Engineering News-Record

Devoted to Civil Engineering and Contracting
McGRAW-HILL COMPANY, INC.

March 6, 1919

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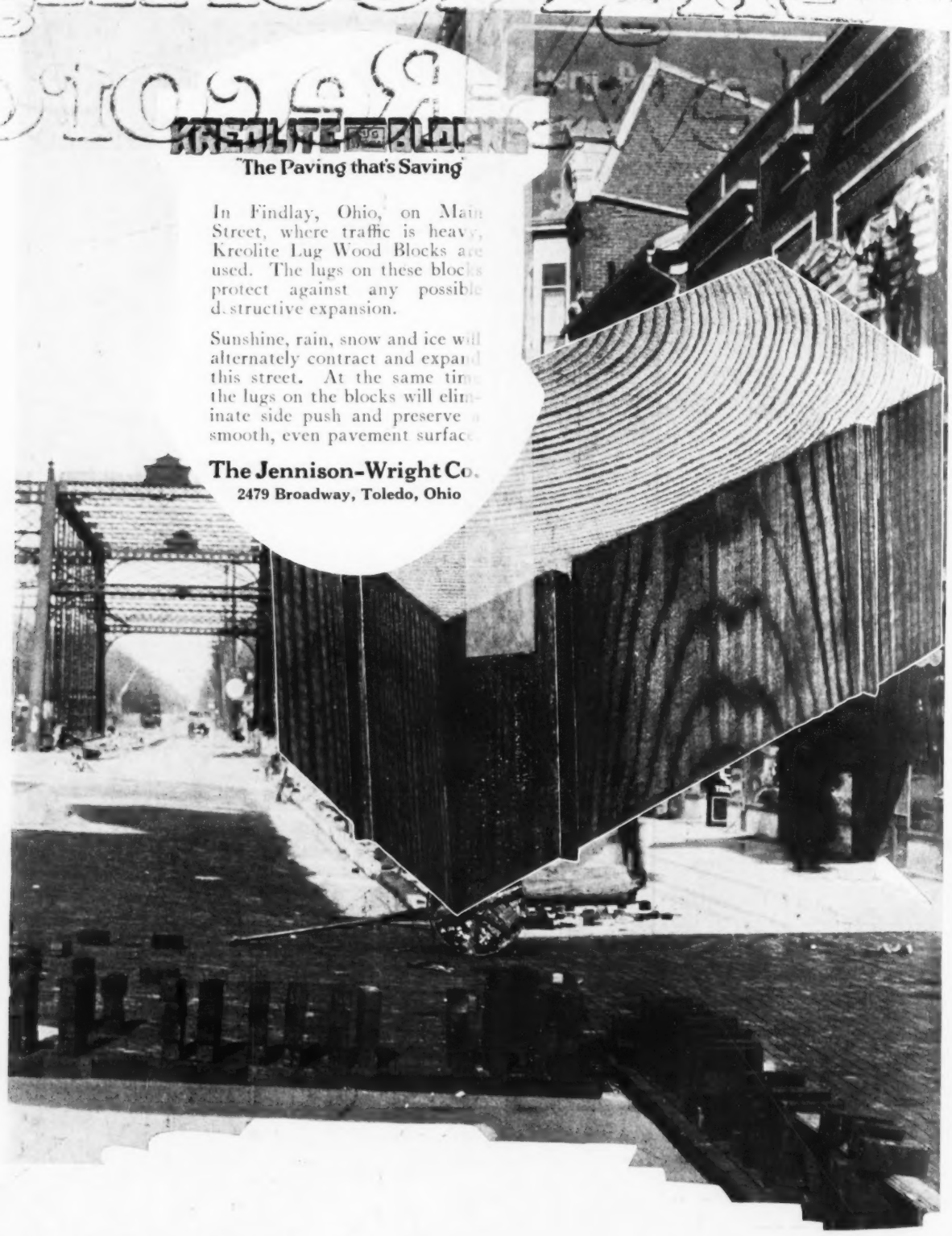

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"The Paving that's Saving"

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ENGINEERING NEWS-RECORD

A WEEKLY JOURNAL
DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

E. J. MEHREN, *Editor*

CHARLES WHITING BAKER, *Consulting Editor*

Volume 82 — NEW YORK, THURSDAY, MARCH 6, 1919 — Number 10

Controlling and Using Colorado River Floods

FOR good or for evil, the possibilities of the Colorado River are great. Uncontrolled, that mighty stream may in any year surpass its ravages of the past and return the now fruitful Imperial Valley to a desert region—hopelessly irreclaimable should channel changes make irrigation impossible. With the river controlled, the future of the Imperial Valley will be insured and its possibilities increased. In addition, other areas may be made to produce bountiful crops, and vast water powers made possible. A storage project for achieving this, but with its more immediate aim to prevent floods and utilize water at and near Yuma, is outlined on p. 456 by one of the hydraulic engineers of the United States Geological Survey. His story compels interest. His closing plea for additional funds for more study of the Colorado problem deserves attention.

Making Supporters Through Committee Work

ONE of the wholesome signs in engineering society activities is the broadening of committee work. With the tendency to become interested in local civic affairs there is the inevitable consequence that committees on various civic activities will be appointed. These give opportunity for those who for a variety of reasons have abstained from service on technical committees. Thus, the interest in the society is broadened by bringing into activity a larger percentage of the society's membership. The same movement is in evidence in the Engineering Council. Its national service and licensing committees are composed of engineers widely scattered geographically. Moreover, they are not members of the council. One of the certain ways of making staunch supporters for an institution is to put inactive men to work.

Sound Practice in Bridge Detailing

BRIDGE engineers and detailers will be well repaid by a careful reading of Mr. Godfrey's letter to the editor in last week's issue, p. 441, and the reply by Mr. Metzger, published on p. 486 of this issue. One of the most important results of recording details of such bridges as that at Salem, Ore., here under discussion, lies in the constructive criticism thus developed. Mr. Godfrey has pointed out details considered to violate principles of sound engineering practice. Mr. Metzger would justify eccentric load application by "architectural requirements," and explain the use of bent members and connection plates virtually by appealing to the "factor of ignorance." Most engineers will agree that the joint detail at the rocker support of the pony span is an example of questionable practice. Whether or not an attempt was made to approximate to actual stress conditions in the several cases to which Mr. Godfrey refers, the lesson in this discussion for bridge detailers is plain: While mathematical analysis based upon fair fundamental assumptions can always be utilized for more or less exact knowledge of stress conditions, the best practice would avoid altogether details that involve eccentric loading or bring large torsional stresses to bear on bridge members.

Federal Government Has No Public-Works Policy

FOUR months after the armistice was signed, the President of the United States admits that the administration has no policy of reconstruction, in so far as that word applies to labor or public works. That is the only interpretation to be put upon Mr. Wilson's remarks to the Governors' and mayors' conference in Washington Mar. 3. "The primary duty of caring for our people in the intimate matters that we want to discuss here," he said, "falls upon the states and municipalities, and the function of the Federal Government is to draw the executive minds of the country together, so that they may profit by each other's suggestions and plans, and so that we may offer our services to coördinate their efforts in any way that they may deem it wise to coördinate." Clearly, this puts it up to the states, the counties and the cities. Public work must be started at once if the initial push to industrial activity is not to be delayed. Everyone seems agreed on this, but no one—or at least hardly anyone responsible—is doing much more than to accept it as a proper policy. When at this rather late day the Federal Government called together a conference of the Governors and mayors there seemed hope that some definite centralized scheme for action would be presented by which the states and cities might be encouraged to go ahead, and to go ahead immediately. Such a hope, apparently, is not to be realized. Instead, there is merely a continuance of the mild encouragement that has marked so much of the recent Department of Labor publicity bulletins, and optimistic expectation of some universal panacea arising from the conference. Whatever else the visiting mayors and Governors get out of the final two days of the meeting, they may be sure, after attending the first day, that they will have to go back home determined each to work out his own salvation.

Another Step Toward Society Coöperation

ANOTHER step and a long one toward uniting the engineering profession by coöperation between national and local engineering societies has been taken. The first advance was made last year, when the Cleveland Engineering Society adopted a plan for intermembership with the national engineering societies. Similar overtures were made soon after by the Engineers' Society of Western Pennsylvania. After a lapse of some months the American Society of Mechanical Engineers does itself and the profession the credit of meeting the local society proposition half way. Very properly, the first union of the mechanical engineers will be with the Cleveland Engineering Society. The elements of the plan are given on p. 495. It is not to be expected that the national societies will make similar arrangements immediately with all the local societies of the country, for in such departures it is best to make haste slowly, and in this particular case it will be necessary to weigh carefully the aims and accomplishments of each local society before according to it joint membership in the national societies.

Highway Builders in A. E. F. Needed Here

AN APPEAL that will get universal support in engineering and construction circles was made in a resolution passed last week at the convention of the American Road Builders' Association. It authorized the appointment of a committee to lay before the officials of the Government the urgent need, in the interest of highway work, to return to this country at once the road builders enlisted with the overseas forces. Highway departments and highway contractors' organizations throughout the country are short of experienced men. Under any war condition this would have been true, but the trouble is aggravated in the road-building field because of the strenuous campaign waged to get volunteers who were *competent to act as foremen and superintendents*, particularly for the Twenty-Third Engineers. It was set forth that pick and shovel workers were not wanted, but rather those who could direct work. Due to this appeal, a magnificent body of men was recruited. They are now sorely needed, particularly in view of the imminence of a heavy highway-construction program. Efficient handling of work depends on having an adequate force of men capable of directing operations. Therefore, highway engineers and contractors, deprived of the needed services of the men in the Army, should support the appeal of the road-builders' association, and urge upon the War Department the very great necessity of an immediate return of the road-building forces.

Nature Promotes Better Highways

SELDOM has there been such a swing of opinion away from earth roads as exists in Iowa today. The Governor has turned around completely, and is now an ardent advocate for hard surfaces. Nature, not to be outdone, has this year been so prodigal with heat units that the dirt roads during the winter have been practically impassable. Light graveled roads have been cut through, and under heavy hauling the best gravel has shown signs of utter destruction. Commenting on the situation, the *Service Bulletin* of the Iowa Highway Commission says: "Scores of the people who were the most enthusiastic advocates of the earth road as sufficient for Iowa's needs have lost patience and have come to the conclusion that it is a waste of energy to continue further on such a policy. Most of the county systems have reached a stage where the dirt surface has every advantage of good grade, good surface and good underdrainage. There has also been the advantage of fairly persistent dragging. If earth roads are ever going to be entirely satisfactory for heavily traveled roads, they have been given every chance in Iowa the last few years. With the grades built and drainage taken care of, the next logical step, if the dirt surface fails, is to put down a strip of hard surfacing." This is sound doctrine.

Railway Bridge Impact Allowances

TAKING proper account of the effect of moving trains on bridges—a crucial problem since the earliest days of the iron bridge—will reach a new stage of progress if the American Railway Engineering Association adopts the impact formula which it has had as a tentative standard for several years. The formula invites confidence, since it is based on tests to determine the stress increase caused by the motion of a train. Unfortunately, bridge men of wide experience raise certain objections to its practical value, and this latter, of course, is the real touchstone.

As compared with the earlier standard, the widely used empirical formula $I = 300/(L + 300)$ of the late C. C. Schneider, the new one will give higher impact values for short spans and very much lower values for long spans. Both effects are of questionable value.

Not only does the new formula demand higher impact allowance for short spans when L, the length, is taken at the same figure, but it adds to this effect in the case of main girders of bridges carrying two or more tracks. The old formula took L as the loaded length which produces maximum stress, and thus automatically reduced the impact tax on a multitrack bridge. The new formula, taking L as the span length, imposes severer requirements, which are only partly relieved by the provision of live-load reduction factors for multitrack bridges. It results herefrom that more metal will have to be used in bridges shorter than 100-ft. span.

But these, in modern practice, are plate-girder spans. Floor systems, which are also affected, are likewise of plate-girder construction. No type of bridge, it is safe to say, has given better account of itself, in many years of experience, than the plate-girder span. If this type is now to be penalized by a higher impact addition, is the procedure to be regarded as logical or in the interests of economy? It is true that floor systems have often shown weakness, but this was due to increased engine weights and not to impact. The fact remains that plate-girders, our most robust steel members, do not need the further increase of metal which the new formula will require.

Applied to long spans, on the other hand, the new

formula gives remarkably low figures, 5 to 15% impact in place of the 25 to 40% which the old formula yielded. At first sight this is an improvement, for no one believes that 30% impact really occurs in the main members of a 700-ft. span; the 6% which the new formula demands is more logical. However, true impact is not the only action that an impact formula must cover.

Whether we wish it or not, we actually provide by the impact formula for all live-load effects, of whatever nature, even though they may not be measurable as axial stress increments. The formula, further, must serve as a blanket allowance to cover the secondary stresses. For a long time to come, secondary stresses will be computed only for extraordinary spans, and even here the reliability of the calculations is doubtful.

Briefly stated, the fact is that under the methods of today the impact formula constitutes the only discrimination between the effects of a moving train on a real bridge and the effects of dead weight on an ideal bridge. Do these effects differ by only 5 or 6%? Unless this allowance does actually cover all live-load effects and their secondary stresses—always more severe than dead-load secondaries—the new formula will have the rather curious result of permitting a higher working-stress for live load than for dead load. In this aspect the operation of the old formula is manifestly fairer.

We have quoted these practical considerations rather fully because the matter of impact increments touches very closely some of the problems at the core of bridge design. The subject is complex; but its practical aspect is more simple, and this, we believe, is controlling.

The objections offered from the standpoint of practice do not question the theoretical excellence of the formula or the merits of the investigations on which it rests. They are concerned solely with the service value of the formula and with its influence on the efficiency of bridge design, and they claim attention accordingly.

Need for a National Technical Highway Association

LAST week the American Road Builders' Association drew to its convention a representative and interested group of highway engineers and builders from the Eastern states. Ohio was represented, as well as the Southern states, but, on the whole, the description of the gathering as an Eastern meeting is correct. The association is now the only one in the highway field which devotes itself to technical matters and professes a desire to be national in scope. There is need for such a national body, but whether the American Road Builders will be that association is doubtful.

In the first place, it is on a false basis so far as technical strength goes; it admits material and machinery manufacturers and salesmen on the same basis as engineers and contractors. Second, the Eastern dominance that has restricted the organization in the past is as strong as ever, and is not likely to be abated. The geographical representation in the directorate is wide, but it is scenic rather than active.

It may be seriously questioned whether an organization with headquarters in New York can become the national association of road builders. The gravitation toward New York, natural in some industries and professions, does not obtain in the case of highways. New York may be more important to the banker, the manufacturer, the importer, the engineer, than any other city in the country but the logical headquarters for a national road-builders' association is near the population center. Doubtless similar reasoning located the Associated General Contractors of America in Chicago.

But even if there is no immediate effort to establish a national association in Chicago we do not expect the American Road Builders' Association to be anything but an Eastern organization—unless there should come a sharp break with its traditions and management.

All of which points to the need for a strong technical highway association of national scope, and does not detract from the fact that last week's convention was a good one and that as an Eastern organization the American Road Builders' Association can be of much value to road builders and the road-building art.

How Much Education For Minor Engineering Positions?

MR. GOODELL'S letter on p. 482 of this issue sounds a new note in the current discussion of engineering compensation. His thought, in brief, is this: Men should not be educated beyond the jobs they are likely to hold. Conversely, every man who goes through a technical school feels he has a guarantee that he will be given a prominent position at free-from-worry compensation. Consequently, if the busy world refuses to make good the guarantee the individual feels that he has been victimized. For remedy, Mr. Goodell proposes that for the minor positions in engineering—such as surveying, inspection and the simpler jobs in designing—there be high-school (or trade-school) courses.

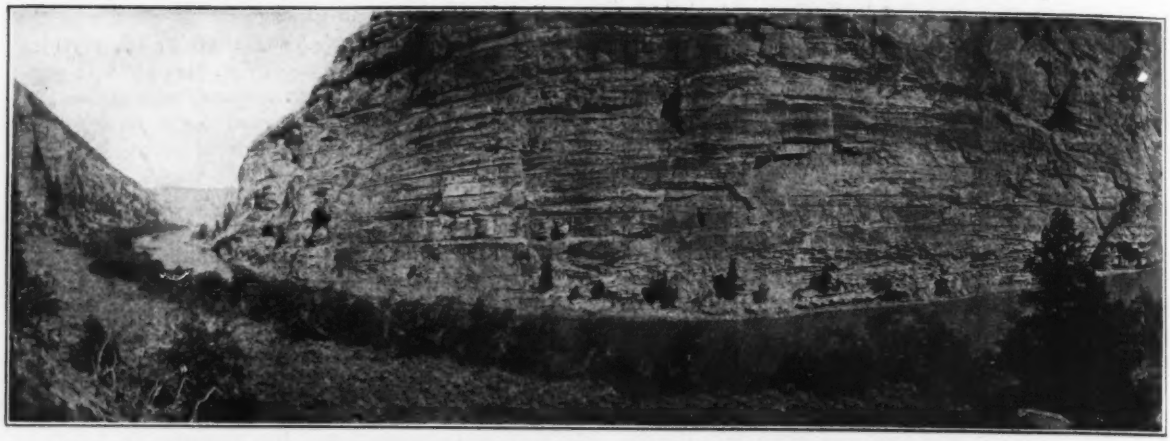
Here surely is much food for thought. The suggestion fits in with the theory of the technician courses given by the Army during the war to prepare airplane mechanics, concrete workers, etc. Moreover, its purpose is similar to that of the plan for two-year courses in engineering in technical schools. Such courses would be elected by those unable, for financial or other reasons, to stay for four years, or whose ability fitted in better with quite narrow specialization than with the broader work for which a four-year course is a preparation.

To Mr. Goodell's plan less objection will probably be made than to the two-year college courses here suggested, for many who see the wood-hewing and water-drawing character of numberless minor positions on engineering work will protest vigorously against any plan that might seem to lower engineering standards. In our judgment, however, engineering standards are lowered more by having within the profession a lot of discontented men than by instituting short, highly specialized courses. Both plans are in the interest of human conservation. Neither controverts the ideas of the Mann report. In fact, by the method of testing Dr. Mann proposes it may eventually be possible to determine which men had better stop at the high school and which might with profit spend two years in college. Mr. Goodell's plan, to be workable, requires that engineers recognize the correctness of his analysis and endeavor to divert from college those who had best stop their work on completing the high-school course.

Colorado River Flood Control by Storage

Reservoirs at Available Sites Would So Cut the Flood at Yuma as to Safeguard the Imperial Valley—Water-Power and Irrigation Opportunities—A Hundred More Gaging Stations Needed

By E. C. La Rue
Hydraulic Engineer, United States Geological Survey, Pasadena, Cal.



HORSESHOE CANYON OF THE GREEN RIVER IN UTAH, SHOWING FLAMING GORGE DAM SITE AT THE LEFT
A dam here with a spillway 255 ft. above low water would form a reservoir extending well up into Wyoming with a capacity of 4,720,000 acre-feet.

STORAGE on the Colorado River would control the floods which threaten the Imperial Valley. Great power and irrigation possibilities might also be developed by dam building and storage. In a broad political sense, the problem is a large and complicated one, because it involves not only seven large states but also the Republic of Mexico. This article will be devoted chiefly to flood control by storage, but some consideration will also be given to the other aspects of this great stream.

The Colorado is formed by the junction of the Green and Grand Rivers in southeastern Utah. It flows in a southwesterly direction across northwestern Arizona, and forms the boundary between Arizona and the States of Nevada and California. The Green, which rises in the Wind River Mountains in Wyoming, drains an area of 44,400 square miles. The Grand rises on the western slope of the continental divide in central Colorado, and drains an area of 25,900 square miles. Including the Green, the entire length of the Colorado River is 1700 miles. The total fall from source to mouth is more than 14,000 ft. The drainage basin of the Colorado (244,000 square miles) comprises the southwestern part of Wyoming, the eastern half of Utah, the western part of Colorado, practically all of Arizona, and small portions of California, Nevada, New Mexico and Old Mexico. Most of this area is arid. The streams receive their main supply from the melting snow from the high mountains of Wyoming, Utah and Colorado.

Irrigation and Water-Power—Some of the largest irrigation, storage and water-power projects in the Western United States are in the Colorado River basin. When these projects are completed, probably more than $100,000,000 will have been expended. Considering the basin as a whole, the area irrigated in 1913 was about 1,600,000 acres. By proper regulation and control of the water-supply the irrigated area in the basin may be increased to about 7,000,000 acres.

The present developed water power in the Colorado River basin is about 76,000 hp. The total undeveloped water power may exceed 3,000,000 horsepower.

Flood Control—That the floods of the lower Colorado should be controlled was shown by the writer in his report, "Colorado River and Its Utilization," published by the United States Geological Survey as Water-Supply Paper 395.

The elevation of the water surface of the Colorado River at Bulls Head Rock (see map) is 500 ft. above sea level. The distance by river between Bulls Head Rock and the Gulf of California is 370 miles; the average fall in this section of the river, therefore, is 1.35 ft. per mile. Between Bulls Head and Yuma, Ariz., about 200,000 acres of irrigable land are subject to overflow during periods of high run-off. From Yuma to the Gulf the river flows through its delta, which is made up of silt brought down and deposited during past centuries. At low stages the river winds through the delta in a channel fairly well defined by banks 10 to 12 ft. in average height; at high stages it overflows its banks at many points. After the river has flowed in one channel for a number of years, its bed and banks are built up by silt deposits, until the stream itself occupies a ridge on the delta. As the slope of the delta is greatest toward the north and west, the river during flood periods is continually seeking a new channel to Salton Sea. Several million dollars have been expended by private interests and the Federal Government in constructing more or less temporary levees and protective works to prevent overflow of the Colorado into Salton Basin. The value of the property in Imperial Valley subject to injury by overflow has been

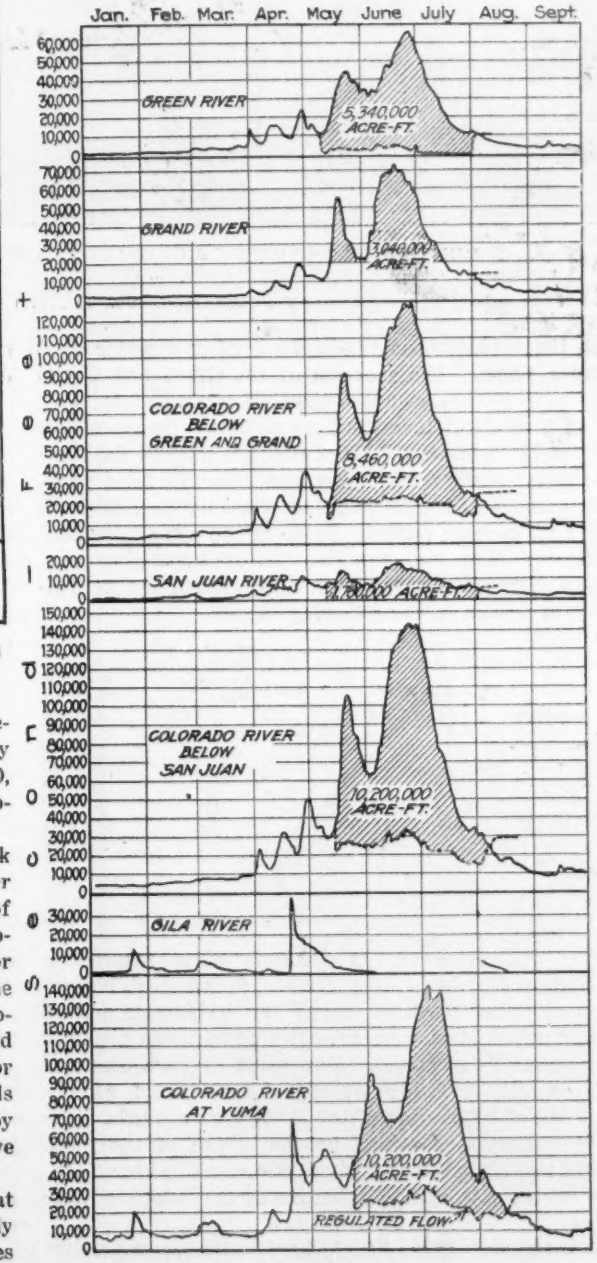
PROPOSED FLOOD-CONTROL RESERVOIR SITES IN THE COLORADO RIVER BASIN

variously estimated at $30,000,000 to $50,000,000. Between Bulls Head Rock and the international boundary are properties valued at $10,000,000 to $15,000,000, which also need protection from the floods of the Colorado.

Obviously, no amount of levee construction and bank revetment will prevent high-water stages on the lower Colorado, and if floods are not prevented thousands of dollars must be expended annually in maintaining protective works on the river below Bulls Head Rock. For the control of the extremely high stages only one method is available—the construction of properly located storage reservoirs of sufficient capacity to hold back the flood-making waters. If by this means all or the greater part of the overflow is prevented, the lands along the lower river can be adequately protected by bank revetment, and the cost of maintaining protective works will have been reduced to a minimum.

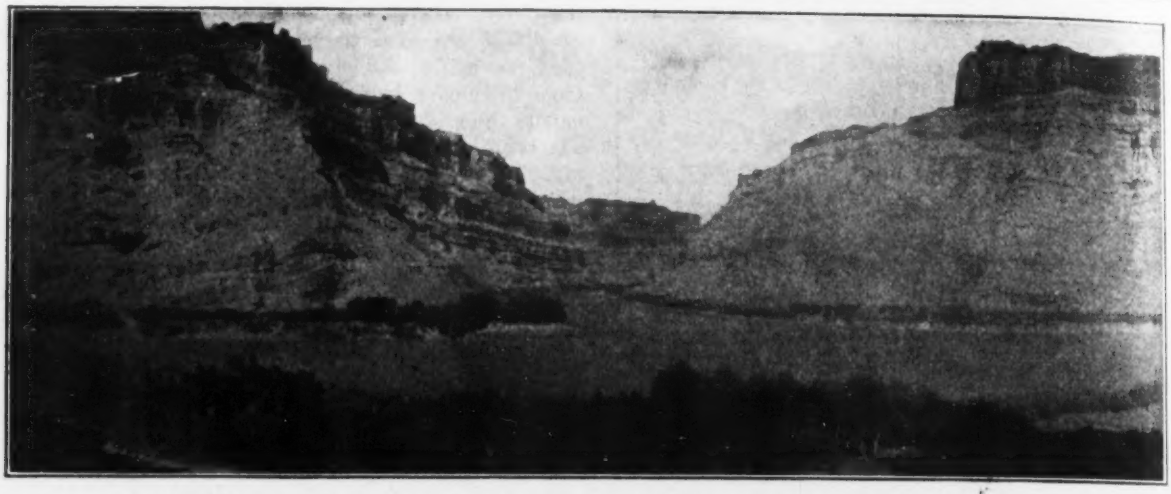
Prominent engineers have expressed the opinion that the influence of reservoirs on flood prevention rapidly diminishes down stream, and the influence of levees correspondingly increases in importance as a method of flood protection, and that for the lower alluvial reaches of long rivers, such as the Mississippi and Colorado, levees afford the only sure means of flood control.

The foregoing statement is not correct when applied to the Colorado River. Although the Colorado, including the Green, is 1700 miles long, and drains an area of 244,000 square miles, the precipitation and run-off from the lower half of the basin is small compared with that from the upper half. At Yuma, Ariz., 92% of the annual run-off is contributed by that part of the drainage basin above the Utah-Arizona line, which is 700 miles above Yuma. The Green and the Grand Rivers, which unite to form the Colorado, drain 70,300 square miles, which is only 28% of the Colorado River basin;



DAILY FLOW OF THE GREEN, GRAND, SAN JUAN, GILA AND COLORADO RIVERS FROM JAN. 1 TO SEPT. 30, 1917

The irregular curve represents the daily flow at each river station. During February the flow at Yuma was less than 10,000 sec.-ft., except during the last two days; during the first four days in July the flow was more than 140,000 sec.-ft. The shaded area on the chart shows the part of the flood that might have been stored in reservoirs. The dotted line below the shaded area indicates the flow resulting from such storage. The chart shows that at Yuma the flood flow could have been reduced from 143,000 to 33,000 second-feet.



JUNCTION OF THE GREEN AND GRAND RIVERS IN UTAH AT OR NEAR PROPOSED DAM SITE

A reservoir with a capacity of 8,600,000 acre-ft., extending for many miles up both rivers, could be formed by a dam with a spillway 270 ft. above low water. Such a reservoir, with a 2,000,000-acre-ft. reservoir on the San Juan River, would have reduced to 25,000 sec.-ft. the flood flow of the Colorado at Yuma in 1917.

yet these rivers contribute 76% of the water that passes Yuma. The junction of the Green and Grand Rivers is 1000 miles above the Gulf of California.

As a result of investigations made by engineers employed by the Federal Government, sufficient data are available to show that there are reservoir sites properly located and with sufficient capacity to hold back the flood-making waters. Some of the more important reservoir sites are shown on the accompanying map. The capacities of these sites, all of which can be utilized, are given in the following table:

Name of Site	Elevation of Spillway Above Low Water, Ft.	Capacity, Acre-Feet
Flaming Gorge	200	2,600,000
Flaming Gorge	255	4,720,000
Juniper Mountain	200	1,600,000
Ouray	170	8,000,000
Ouray	190	10,000,000
Ouray	220	15,000,000
Green-Grand	180	3,330,000
Green-Grand	200	4,250,000
Green-Grand	240	6,460,000
Green-Grand	270	8,600,000
Kremmling	100	574,000
Kremmling	150	1,240,000
Kremmling	200	2,200,000
Bluff	214	1,600,000
Bluff	264	2,600,000

The utilization of the Colorado River presents a complicated problem: The extreme floods must be prevented, water must be stored for irrigation, and at many points it may be desirable to regulate the flow for power development. The value of each site and the capacity to which it should be utilized will be determined by a study of the problem as a whole. Each large undertaking should be but a unit of the great project which, when completed, will result in the utilization of the entire water resources of the Colorado River basin.

The Colorado River Flood of 1917—During the winter of 1916-17 the snowfall in the upper basin of the Colorado River was unusually heavy. The spring of 1917 was cool. On May 10 the upper tributaries began to rise, and the automatic water-stage recorders maintained by the United States Geological Survay gave warning that the flood period was near. Fourteen days later the flow of Green River increased to 42,400 sec.-ft., and reached its maximum discharge of 65,900 sec.-ft. on June 27. The maximum flood flow of the Grand River —73,200 sec.ft.—occurred June 19-21. On June 28 the peak flood of 129,000 sec.-ft. occurred immediately below the junction of the Green and Grand Rivers. The San Juan River contributed 18,700 sec.-ft. on June 17, and with the unrecorded flow of the Frémont and Escalante Rivers, the maximum flow of the Colorado River at the Utah-Arizona boundary reached about 147,000 sec.-ft. June 25. The maximum discharge for the year at Yuma, 143,000 sec.-ft., was recorded July 4. This was one of the greatest summer floods ever recorded on the lower Colorado. The levees were overtopped in the vicinity of Needles and near Volcano Lake, in Mexico.

It will be interesting to analyze the stream-flow records and determine to what extent the flood of 1917 could have been prevented by means of storage. A chart has been prepared on which the daily discharge of the Colorado and its principal tributaries is shown for the period of Jan. 1 to Sept. 30, 1917.

The flow of Green River was obtained by adding the flow of San Rafael River to the recorded flow of Green River at Little Valley, Utah. These stations are about 90 miles above the mouth of the Green. The gaging station on Grand River is near Cisco, Utah, about 90 miles above the junction of the Green and Grand Rivers. No tributaries of appreciable size join the Grand River below the gaging station near Cisco. During the flood stage it requires about 24 hours for the water to flow to the junction of the Green and Grand Rivers from the gaging stations above mentioned. The combined flow of the Green River at Little Valley, the San Rafael near its mouth, and the Grand at Cisco, represents with fair accuracy the flow of the Colorado immediately below the junction of the Green and Grand Rivers. By adding the flow of the San Juan River, the discharge of the Colorado below the mouth of the San Juan is obtained. This latter record, as shown on the chart, is approximately correct, except that the flow of the Frémont and Escalante Rivers has not been added. No record was kept of the flow of these streams, but it is

unlikely that they increased by more than 3000 sec.-ft. the maximum flood of the Colorado. The daily discharge of the Gila River was placed on the chart to show that this tributary was dry while the Colorado was in flood from June 5 to Aug. 1.

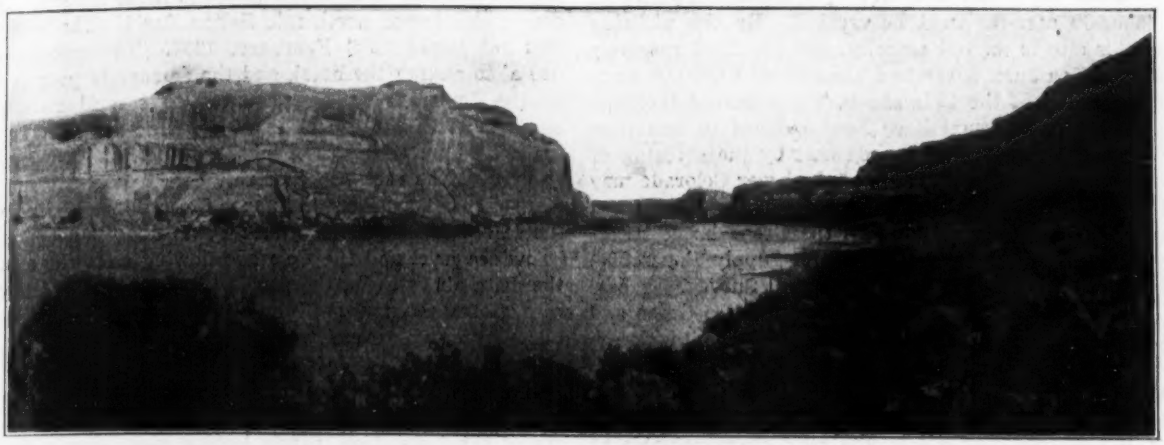
There is a reservoir site on the Green River at Ouray, Utah, where a capacity of 10,000,000 acre-ft. may be obtained by raising the water level 190 ft. The capacity of this site is much greater than that required to control completely the flow of Green River below the mouth of the Duchesne and White Rivers. Had this reservoir been in operation in 1917, the portion of the flow of Green River shown by the shaded part of the chart could have been stored. The peak flood of Green River at its mouth would have been reduced from 65,900 to 5200 second-feet.

Only preliminary data are available relating to the possibilities of storage on the lower Grand River. It is believed that there is a feasible dam site on Grand River a few miles above its mouth, where a capacity of 3,000,000 acre-ft. may be obtained, and there is another storage basin on Grand River near the mouth of the Dolores. The Kremmling site, near the headwaters of the Grand, affords storage capacity of 2,200,000 acre-ft. for a dam 230 ft. in height.

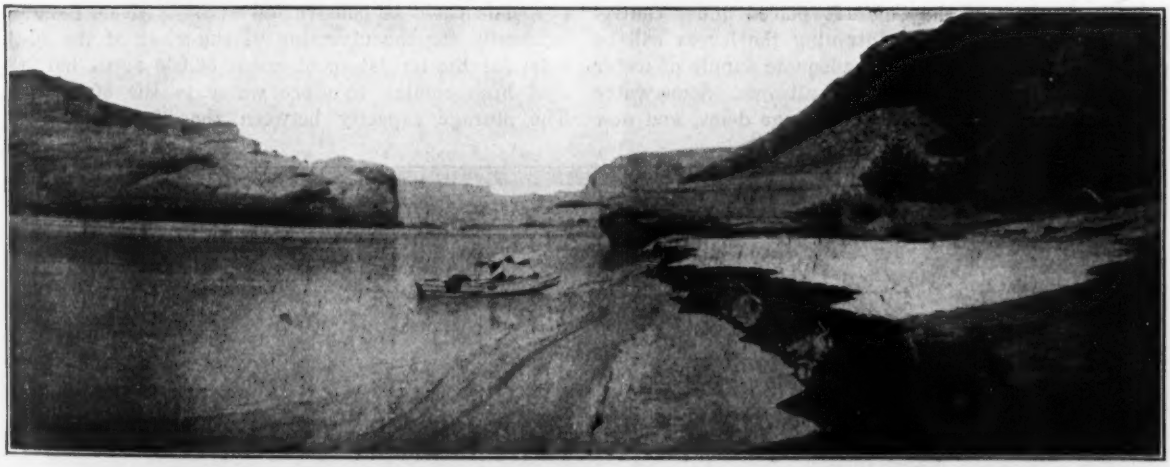
The writer has taken a pessimistic view of the possibilities of storage on the lower Grand, and has assumed that it would be necessary to allow 20,000 sec.-ft. to pass so that the capacity of the reservoirs would not be overtaxed. Under this assumption, the flood flow of the Grand River could have been reduced from 73,200 to 20,000 sec.-ft. by the storage of 3,040,000 acre-feet.

On the San Juan River, near Bluff, Utah, a dam 264 ft. high would give a storage capacity of 2,600,000 acre-ft. As shown by the chart, the entire flow of San Juan River could have been cut off during the flood period, and the amount of water stored would have been 1,780,000 acre-ft., or 920,000 acre-ft. less than the capacity of the reservoir. The San Juan is silt laden, and it may be necessary to build retarding basins on this stream.

Referring again to the chart, the shaded portion shows that part of the flood flow at Yuma which could



BEDROCK REACHES THE SURFACE FROM SHORE TO SHORE AT NO OTHER KNOWN POINT ABOVE THE GRAND CANYON
This point is 21 miles above the Escalante River and 100 miles below the junction of the Green and Grand Rivers



THERE IS A HEAVY SILT DEPOSIT 12 MILES BELOW THE MOUTH OF THE SAN JUAN RIVER
This and the other pictures shown were taken by the author while making a boat trip through the cañons of the Green and Colorado Rivers in 1915.

have been held in storage reservoirs in the upper basin. The unshaded area below the dotted line shows the regulated flow. The maximum flood at Yuma could have been reduced from 143,000 to 33,000 second-feet.

By the building of a dam below the junction of the Green and Grand Rivers that would raise the water level 270 ft., a reservoir having a storage capacity of 8,600,000 acre-ft. could be created. By the utilizing of this site to its full capacity, and the Bluff reservoir site on San Juan River to a capacity of 2,000,000 acre-ft., the flow of the Colorado at Yuma during the flood period of 1917 could have been reduced to less than 25,000 sec.-ft. It is thus seen that by the utilizing of two reservoir sites the floods of the lower Colorado may be prevented. The site at the junction of the Green and Grand Rivers is known as the Green-Grand reservoir site and is described in Water-Supply Paper 395, issued by the United States Geological Survey.

About 100 miles below the junction of the Green and Grand Rivers there is a section where solid rock extends across the channel of the Colorado River. This is the only point on the Colorado above the Grand Cañon where bedrock is known to extend across the channel at the surface. This dam site may prove valuable at some future time in connection with the development of storage and water power. Instrumental surveys have never been made on this section of Colorado River. The amount of silt carried by the Colorado at this point is comparatively small. San Juan River contributes the greater part of silt found in the Colorado above Grand Cañon.

The above data are submitted as proof that by utilizing two reservoir sites, or a combination of three or four sites, the summer flood on the lower Colorado in 1917 could have been prevented.

The sudden floods from the Gila River will always be a menace to the water users below Yuma unless these floods are controlled by storage in the Gila basin.

With the flow of the Colorado placed under control by storage, the cost of maintaining the levees will be reduced to a minimum and an adequate supply of water for irrigation will be available for all time. Some water power may be developed at the storage dams, and new lands may be placed under irrigation in the upper basin. As a result of storage, the water-supply would be sufficient at all times to meet the demand for the irrigation of more than 2,000,000 acres of new lands on the lower river.

Emergency Storage Dam at Bulls Head Rock—During the summer of 1906 the Colorado River changed its course and flowed north into Salton Basin. The break was not closed until February, 1907. The cost incidental to closing the break and the damage to property in the Imperial Valley amounted to several million dollars. With the exception of construction of levees and works protecting the banks, nothing has been done to prevent the recurrence of this catastrophe. A sudden summer flood from the upper Colorado may overtop the levees at any time. With their lands and homes below sea level and the Colorado flowing on a ridge in the delta above them, the people in the Imperial Valley cannot feel secure until every precaution has been taken to prevent overflow and to keep the river in the channel leading to the Gulf of California.

It was the floods from the Gila River that overtopped the levees and caused the break in 1905. These floods are of short duration, rarely lasting more than a few days, yet the break was not closed in time to prevent the summer flood water from the upper Colorado from flowing north into Salton Basin. If it had been possible to shut off the flow of the Colorado for a period of two weeks, the break could doubtless have been closed if a railroad trestle had been constructed across the crevasse and cars loaded with rock had been in readiness. The writer believes that by the utilization of an emergency storage dam at Bulls Head Rock the river below the Imperial Canal heading can be made dry at any time for a period of three weeks when the stage of the river is 10,000 sec.-ft. or less. With such a dam in operation the Colorado might flow north into Salton Basin for a short period but not for two years.

A dam could be constructed at Bulls Head, designed primarily for the diversion of the river at the 20-ft. level for the irrigation of about 56,000 acres, but carried high enough to store water to the 60-ft. level. The storage capacity between the 20-ft. and 60-ft.

COLORADO RIVER CANYON EIGHT MILES ABOVE LEE FERRY, ARIZ., WHERE WALLS ARE ALMOST 1500 FEET HIGH

levels is 243,000 acre-ft. If a break in the levee should occur below the heading of the Imperial Canal during the summer floods, preparation for closing it could be made while the river was still flowing into Salton Sea, and when the discharge had fallen to 10,000 sec.-ft. the spillway and canal head gates at Bulls Head could be closed. The Palo Verde, Imperial and Yuma canals could take care of 5000 sec.-ft., and the remaining 5000 sec.-ft. could be stored for 24 days, during which time the river channel at the break would be dry and the break could no doubt be effectively repaired. The capacity of the reservoir above the 20-ft. level would not be impaired by the deposition of silt, for it would be used as a storage reservoir only in an emergency and for a short period.

A Complicated Problem—The Colorado is not only an interstate but an international stream. The Federal Government, in coöperation with the seven states affected, should formulate plans for the collection of engineering, stream-flow, and water-right data in order that the meager information now available may be increased as rapidly as possible. The interests of each state affected should be taken care of, and there should be a thorough understanding between the United States and the Republic of Mexico regarding the use of the waters of the lower Colorado.

The most neglected part of the investigations of the Colorado River is the collection of stream-flow data. A knowledge of the flow of the main stream and all its tributaries is of primary importance. The amount of water available for the various irrigation, storage and water-power projects must be known before the value of these respective projects can be determined. Especially does this apply to the large storage reservoir sites in the upper basin. The relative value of these sites will depend largely on the volume of the floods and the annual run-off available for storage.

Time is required to collect dependable stream-flow data. The longer the record the more valuable. A hundred or more new gaging stations should be established and a fund of at least $50,000 should be available annually for carrying on this work.

Wider Pavements Needed by Motor Vehicles at Curves

Theoretical Width Determined by Formula—Chart of Necessary and Recommended Widths Plotted for Various Radii

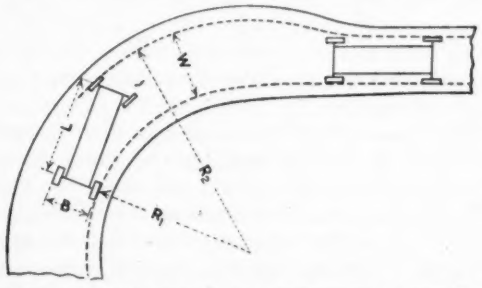
By G. S. Eaton

Assistant Division Engineer, Promotion Bureau, Universal Portland Cement Company

Extra width required by modern motor trucks when rounding curves should receive careful consideration when narrow pavements for country roads and driveways around industrial plants are designed. Too narrow a roadway means traffic inefficiency; too wide a pavement requires unnecessary expenditure. The adoption, for general hauling, of large trucks, which have a longer wheel base and greater width than horse-drawn vehicles, and a peculiar action in turning due to the fixed front axle, has changed traffic conditions. Even on the wider city streets, especially at intersections, attention must be given to these developments.

The action of a truck in rounding a sharp curve will be made clear by reference to the illustration which shows a truck turning on a one-lane pavement. Assuming that the machine is turning at constant radius, the width of the pavement theoretically required can be obtained by the formulas $R_2 = \sqrt{(R_1 + B)^2 + L^2}$ and $W = R_2 - R_1$, where W is the width of pavement; R_2 the radius of the outside of the outer front wheel; R_1 the radius of the inside of the inner back wheel; B, the out-to-out of rear wheels; and L, the length of wheel base. For example, a truck 7 ft. wide with 15 ft. wheel base requires a roadway more than 10 ft. wide when turning on a radius of 25 ft., in order that it may keep on the pavement. While there are minor inaccuracies in the above formula, such as difference in width at the front and the rear trucks and variations caused by the knuckle joints on the front truck, the error is unimportant, as a safety factor is desirable in any event.

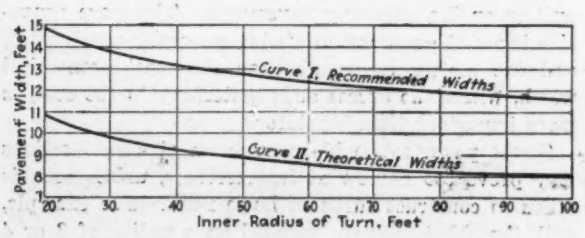
Passenger automobiles also require considerable extra width, as is shown by actual measurements made of the turning radius of an automobile of 137-in. wheel base and 56-in. tread. When the inside rear wheel was turning on a radius of 13.9 ft.—a minimum for this car—the radius of the outer front wheel was found to be 22 ft. Substituting in the formula, $R_2 = 21.8$ ft.,



ACTION OF MOTOR TRUCK IN ROUNDING A CURVE, AND SUGGESTED WIDENING

checking the field measurements almost exactly. The width needed in this case was 8.1 ft., or 72% more than the tread.

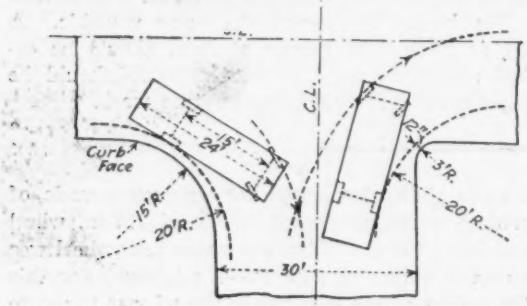
The width theoretically required for a truck with a 15-ft. wheel base and a 7-ft. width, when turning with any inside radius between 20 and 100 ft., can be obtained from curve I. Curve II shows width suggested for actual use, and is based on widening amounts which vary from 4 ft. more than the theoretical require-



THEORETICAL AND RECOMMENDED WIDTHS OF LANE FOR VARIOUS RADII SHOWN GRAPHICALLY

ments for a curve of 20-ft. inside radius, to 3 ft. on a tangent. This gives a pavement 10 ft. wide on straight sections. Where pedestrian traffic uses the road 11 or 12 ft. is preferable, with corresponding increases at turns. The recommended widths are desirable though not absolutely necessary, as they save the time and cost of slowing down for safety. The minimum inside turning radius of the average large truck is slightly less than 20 ft.; with some trucks a larger radius is necessary, and in all cases it is desirable. From curve I it may be seen that the extra width is needed even on curves of considerable radius, 48 ft. requiring about two feet.

Where provision must be made for two trucks to pass on a curve, the total length of the truck attains importance, particularly when there is any overhang



BEHAVIOR OF TRUCKS PASSING AT INTERSECTIONS

beyond the front axle. Although the overhang back of the rear axle is not important when both machines are following arcs of concentric circles, sufficient width should be provided to leave clearance when the arcs are not concentric.

Widths for double-track pavements may be obtained from curves I and II by doubling the values shown for the single track. While this is not exact, the error is small for turning radii of practical importance, and is on the side of safety. The shape of the truck assumes importance where vehicles are expected to pass on the curve, especially the distance from the rear axle to the front of the truck, if the body is of the same breadth throughout. Doubling the values, however, will allow sufficient clearance with the usual truck. That the extra width is needed for some distance past the point of curve is evident from the illustrations. This means that both three-way and four-way intersections on narrow pavements should be widened for some distance beyond the usual points of curvature, where short radii turns are constructed.

Space occupied by motor vehicles in turning is of considerable importance in street construction as well as on the narrower pavements. The more expensive types of pavement are being generally constructed, and the matter of deciding on the most economical width, where the excess adds materially to the cost, is more important than heretofore.

Street pavements wide enough on straight sections may prove too narrow at intersections, unless care is taken to construct curbs of large radii. For example, with the old-style curb, rounded on a radius of 3 or 4 ft., a modern truck of 15-ft. wheel base and 7-ft. width cannot make a right-angle turn from one 30-ft. pavement to another and still remain on its own side of the center line of the street. Should two trucks going in opposite directions, as shown in one of the illustrations, attempt to turn at the same time, with a turning radius of 20 ft. for the inner rear wheel, a collision would be likely to result. But where the curb radius is as great as 15 ft., the two could make the turn safely, with several feet to spare.

With a continuously increasing percentage of motor traffic, driven at much greater speeds than formerly, and with widths of tread up to 7½ ft., the customary 8-ft. lane is too narrow, and a greater margin of safety should be allowed. In all highway improvements of a permanent nature allowance should be made for still further increases in the sizes of motor trucks, as well as for great development in their use.

Licensing Bill Proposed by American Association Committee

THE Committee on Legislation of the American Association of Engineers, L. K. Sherman, chairman, has just prepared a form of licensing bill which is designed to include all classes of engineers, although certificates in each branch are prescribed. In all essential details it is the same as that of the Joint Committee written in 1915 (see *Engineering News-Record* of Feb. 27, 1919, p. 423), but is unique in the fact that it includes land surveyors by name and definition. The following general features are given for comparison with the Joint Committee bill:

A "surveyor" is defined as any person engaged in locating, establishing, or relocating any land boundary lines between two or more land owners, or locating any United States Government, state, county, township, or municipal land survey lines, or the lines of any public streets or roads.

The state board would consist of five members instead of nine—three civil engineers, one mining or electrical engineer, and one mechanical engineer or naval architect, and one professor of engineering in the state university. The regular terms would be four years, instead of six, and the qualifications are the same, except that a three-year residence in the state is required instead of one. Compensation would be paid at the rate of $10 per day, instead of no compensation, as in the Joint Committee's bill. The officers are elected annually instead of biennially and are called chairman, vice-chairman, and secretary, the secretary being a member of the board and being required to furnish a $3000 surety bond. At all meetings a majority shall constitute a quorum; the reports shall be made annually on or before June 30, instead of Feb. 1.

For admission to examination, a $15 fee is required, practice in land surveying is accepted, and as the alternative to six years' practice only two years' practice instead of four is specified in addition to graduation from an engineering school, and the following is added as a part of the graduation requirement of the candidate, "That he is qualified in the knowledge and prac-

tical application of the principles of physics, strength of materials, and mathematics, including trigonometry."

Examinations are held to determine the qualifications *separately in surveying or in any one of the branches of professional engineering.* An additional fee of $10 is required for certificates of registration. *These certificates are issued in the branch or branches of engineering in which the candidate is qualified, or in land surveying,* and authorize the recipient for practice professional engineering or land surveying. A $5 annual renewal fee for certificates is required.

Penalties are provided for violation, which is classed as a misdemeanor; either a fine not to exceed $500 or imprisonment not to exceed three months, or both.

The bill exempts United States Government engineers, etc., and in addition all architects who may be registered under an architects' law. Licensed engineers are exempted from provisions of any act for licensing architects, so far as the term "buildings" in such act may include or be included in the structures enumerated in this proposed act.

Concrete Box Flume Carried Across Gulch on Trestle

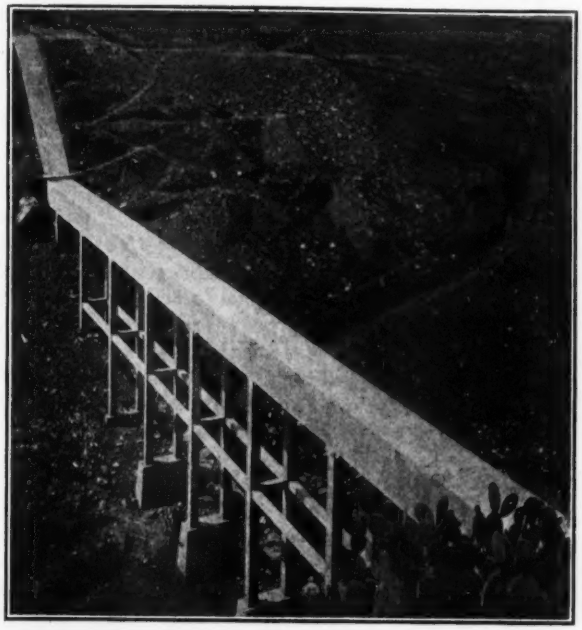
Irrigation System in Hawaii Substitutes Concrete for Steel Which Has Been Customary Material for Such Crossings

By A. W. Collins

Engineer for Maui Agricultural Company, Paia, Maui, T. H.

War embargoes on steel, and particularly on plate steel, in the Hawaiian Islands have forced the sugar plantations to substitute other materials in such structures as have been built of steel. The irrigation flume shown in the accompanying view and drawing is an example of such substitution.

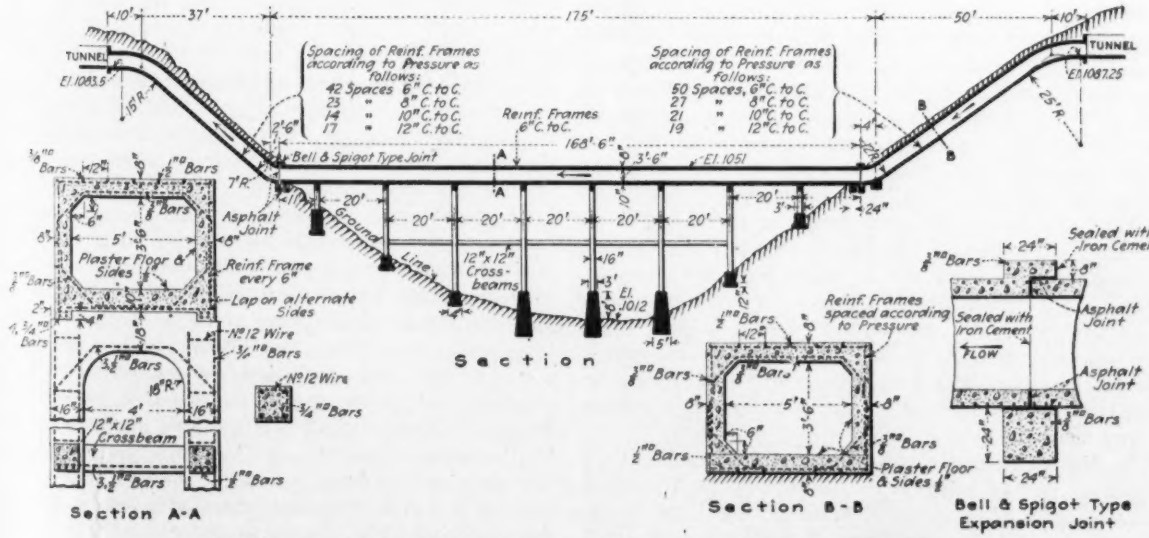
The topography of the Island of Maui is such that there are many box-like gulches running to the sea. These gulches are from 50 to 900 ft. in depth, and require the extensive use of flumes and inverted siphons in the irrigating systems of the sugar plantations. Across one of these gulches, known as Kailua Gulch, an irrigation line was carried across on a reinforced-concrete pressure flume combining the features of an ordinary flume and an inverted siphon. The grade line



SIX-BY-FIVE-FOOT IRRIGATION FLUME IS CARRIED ACROSS HAWAIIAN GORGE ON A CONCRETE TRESTLE

of the intake is 75 ft. above the bottom of the gulch, and the floor of the flume is 36 ft. below the intake, leaving 39 ft. for flume columns and footings. The difference in elevation of the intake and outlet is 4 ft. As shown in the drawing, the flume itself consists of a rectangular box resting on concrete column bents reaching down to prismatic piers in the gulley bottom.

The inclined stacks and flume columns were poured previous to the flume box, a rectangular bell-and-spigot


Spacing of Reinf. Frames according to Pressure as follows:
42 Spaces 6" C. to C.
23 " 8" C. to C.
14 " 10" C. to C.
11 " 12" C. to C.
Reinf. Frames 6" C. to C.
Spacing of Reinf. Frames according to Pressure as follows:
50 Spaces, 6" C. to C.
27 " 8" C. to C.
21 " 10" C. to C.
19 " 12" C. to C.
TUNNEL
El. 1083.5
El. 1087.25
Bell & Spigot Type Joint
Asphalt Joint
Ground Line
12"x12" Cross-beams
Reinf. Frames spaced according to Pressure
Sealed with Iron Cement
FLOW
Plaster Floor & Sides
Reinf. Frame every 6"
Lap on alternate Sides
No. 12 Wire
12"x12" Crossbeam
Section
Section A-A
Section B-B
Bell & Spigot Type Expansion Joint

DETAILS OF HAWAIIAN IRRIGATION FLUME OF REINFORCED CONCRETE

expansion joint being constructed at the back end for connecting the stack to the flume. The flume itself was poured monolithically in 18 hours' continuous work. The steel plates inserted between the stack and flume at the expansion joint were later withdrawn, and the space was filled with an asphaltic cement poured hot. This joint has been under pressure for a number of months, but shows no leakage except some dampness on the outside.

Hydrated lime to the amount of 12% by weight of the cement was used in the concrete. No leakage of the flume or stacks has occurred except by sweating. The labor was entirely performed by Japanese, an American foreman being in charge of the work.

After-War and Motor-Truck Problems Hold Attention of Road Builders

How properly to connect up our national highway system, furnish labor for its construction, and decide upon the quality of the materials to be used for surfacing to support the heavy truck traffic which it must carry, were subjects discussed at the recent meeting of the American Road Builders' Association. These points are emphasized in the following abstracts of papers which created considerable discussion.—EDITOR.

Efficiency of Bituminous Surfaces Under Motor-Truck Traffic

BY PRÉVOST HUBBARD

Chemical Engineer, United States Bureau of Public Roads

FROM experience with pre-war traffic conditions many engineers had classified the various types of pavements with relation to their efficiency under the ordinary variations in traffic encountered on county, state and municipal highways. Their ideas were fairly well fixed on the subject, as was evidenced by more or less consistent practice in their choice of types when reconstruction or new construction became necessary. Just where the dividing line should be drawn between different types of pavements has always been a matter of individual opinion, but in general, with increases in volume and weight of traffic, the increasing efficiency of the bituminous types has been rated as follows: (1) Bituminous surfaces; (2) bituminous macadam; (3) bituminous concrete; (4) sheet asphalt and asphalt block.

Suddenly, and with little opportunity for anticipation, a very large mileage of our important state highways and many of our local county and municipal pavements were subjected to a tremendous increase in heavy truck traffic. This, coupled with an unusually severe winter, and immediately followed by war restrictions and other difficulties, created a serious situation and hundreds of miles of roads of all types failed within a comparatively few weeks or months. These failures were not only sudden but complete, and almost over night an excellent surface might become impassable. Such rapid and complete failures in municipal pavements were of less common occurrence, and as sheet asphalt and asphalt block have always been largely confined to municipal work, failure of these types have not been noted to the same extent as those of the other types mentioned.

In the haste and confusion of war activities, little opportunity has existed for a systematic and comprehensive study of the problem suddenly thrust upon highway engineers. Reports from all parts of the country have, however, established one outstanding fact which has a most important bearing upon any consideration of the efficiency of bituminous surfaces and bituminous pavements. A very large proportion of the failures have been characterized by an almost simultaneous destruction of the entire road structure. When not only the surface but the entire structure fails suddenly, inadequate subgrade or foundation conditions are primarily responsible, and but little basis exists for placing an efficiency valuation upon the wearing course.

Foundation failures in bituminous pavements may be due to one of two causes: Lack of thickness, or inability of the foundation structure to sustain the loads without appreciable internal movement. So far as bituminous pavements are concerned, remedy of the first cause does not affect the general type of construction; but the second cause may have a direct bearing upon possible modifications in design. There is practically no beam action in a broken stone or gravel foundation, and a load applied to the bituminous surface is transmitted quite directly to the subgrade. This load may be so great as to cause an internal movement sufficient to produce disintegration of the pavement.

EXPERIENCE ON CITY STREETS AS GUIDE

In general, experience on heavily traveled city streets has demonstrated the necessity of a slab foundation for any wearing course, and there appears to be no reason why such experience should not serve as a guide for new construction on heavy-traffic state and county highways. With respect to existing gravel and macadam roads, it would seem far safer at the present time to attempt to preserve them under heavy motor-truck traffic by means of surface treatment with bituminous materials, rather than to utilize them as foundations for the construction of new bituminous macadam or bituminous concrete pavements.

Under the same conditions of traffic, bituminous surfaces are most efficient in localities where frost action is either absent or not severe. Such treatments, used in connection with gravel roads adjacent to Army cantonments in the far South, have given reasonable satisfaction even under heavy motor-truck traffic. North of the frost line, and particularly in connection with the treatment of clayey gravel roads which become soft during the spring months, bituminous surfaces are apt to disappear completely. If, however, the gravel road is maintained by dragging and at the end of the thawing-out period is reshaped, thoroughly compacted and again treated with bituminous material, it may be kept in a reasonably satisfactory condition. Under very

heavy motor-truck traffic, however, maintenance costs may be extremely high, so that if a continuation of such traffic is to be expected the construction of a new road may be necessary.

Bituminous surfaces on properly constructed macadam roads subjected to heavy motor-truck traffic may, as a rule, be maintained in localities north of the frost line with less expense and better results than on gravel roads under the same conditions. Such surfaces, under heavy motor-truck traffic, cannot be considered as economical from the ordinary standpoint, but may prove the most efficient temporary method of preserving the existing road until money is available for reconstruction. It is believed, however, that they will not prove efficient unless constantly maintained by a patrol system operating throughout the year. This has been proved on maintenance by the Bureau of Public Roads of experimental bituminous surfaces on the Rockville Pike, Maryland, which is a macadam road having an average traffic of 135 motor drays, 816 motor pleasure vehicles, and 81 horse-drawn vehicles per day during the past year.

With regard to the efficiency of bituminous macadam under heavy motor-truck traffic, there are a number of points to be considered. In general, bituminous macadam has not been thought to be capable of carrying such traffic but, on the other hand, it has almost invariably been placed upon a broken stone or gravel base. Results obtained in the City of Alexandria, Va., by E. C. Dunn, city engineer, indicate that the bituminous macadam, if properly constructed and laid upon a concrete base, may prove quite satisfactory.

The efficiency of bituminous-concrete, sheet-asphalt and asphalt-block pavements under city traffic is so well understood as to require little comment in this paper. If they are laid upon suitable concrete foundations, there is no reason to suppose that the results will not be duplicated on county and state highways subjected to heavy motor-truck traffic. If the foundation is inadequate to support the load, the pavement is bound to fail, but, as previously pointed out, failure cannot then be considered a measure of efficiency of the pavement surface proper.

Materials of Construction and Efficiency

With regard to materials of construction a few comments may not be out of place, as the efficiency of a bituminous surface or bituminous pavement depends not only upon its method of construction but of what materials it is composed. In general, the author's observation and experience has been that the most efficient bituminous carpets are constructed with the heaviest grade of bituminous material which it is possible to apply and make adhere uniformly to the road surface. On old macadam roads it is advisable to keep the thickness of carpet under ½ in.; on certain types of soft gravel it may be of greater thickness, provided there is used a hard and tough coarse-aggregate cover of sufficient size to force into the old gravel surface by rolling. For clay-gravel or sand-clay-gravel roads north of the frost line, it is believed that light superficial treatment with bituminous materials applied cold will prove more efficient than the construction of a bituminous carpet, although neither will be adequate to carry the road through winter.

With regard to bituminous macadam and coarse-aggregate bituminous concrete, there is little to suggest in connection with the grades of bituminous materials ordinarily used. It is believed, however, that even in the northern United States the use of an asphalt cement softer than 120 penetration or a refined tar of less than 120 sec. float test at 50° C. for bituminous macadam is inadvisable if modern heavy motor traffic is to be sustained. It is also believed that more attention should be given to specifying and securing a uniform size, and grading within reasonable limits, of coarse stone, in order to promote uniformity in the penetration of the bituminous material as it is applied, and to produce a surface that will wear as uniformly as possible.

Thickening of Binder Course Desirable

In connection with sheet asphalt and the fine-aggregate bituminous concretes, the tendency to use harder grades of asphalt cement than heretofore used may prove advisable for very heavy traffic conditions. It is quite possible, however, that better results may be secured by a reduction in the compacted thickness of such pavements, with a corresponding increase in thickness of binder course where one is commonly used. For fine-aggregate bituminous concretes which are commonly laid without a binder course, the introduction of such a course not less than 1½ in. thick may prove advisable, with a reduction in thickness of wearing course to not more than 1½ in. Provided the binder course is properly constructed, such practice should tend to produce a pavement less susceptible to displacement under heavy truck traffic. It is believed that even more attention should be paid to aggregate grading than heretofore in order to produce most satisfactory results.

State, City and County Road Systems Should Be a Unit

By Nelson P. Lewis
Chief Engineer, Board of Estimate and Apportionment, New York City

THE need of some kind of system in city streets is universally recognized; that is, the need of a primary system of main thoroughfares by which traffic is enabled to reach any part of the city from any other part with economy of distance and time. The need also of suitable connections between this primary street system and the chief highways traversing the immediate surroundings of the city, or reaching nearby places of interest and recreation, while more slowly realized, is quite apparent. The interest of the city, the county or the state is still largely confined to the system of streets or roads under the jurisdiction or control of these several units, and they have not been regarded as one great system of vital interest to all the people.

This lack of coördination is not a fault peculiar either to the city street system or the rural highway system, but is apparent in both. Rural highways connecting more or less important centers of population are generally much older than any part of city street systems,

except those in the oldest parts of the towns. It might have been assumed that the traffic between these centers of population would continue to follow these old routes, and yet how often it is found that they are reached only through streets of minor importance, often shabby and unattractive, not infrequently by means of awkward and obscure offsets, so that the dominant feeling is one of relief in leaving them or of extreme unpleasantness in entering them.

On the other hand, when a county or state road system is being improved, an increase in the width of such road as it approaches the city, the improvement of its alignment and grades, special attention to its cross-section and drainage, the planting of trees, etc., would be of incalculable benefit and involve little additional cost. Of course, this requires vision, a quality all too rare, and it may even involve the diversion of traffic through bypasses about already existing centers There are abundant instances showing what is daily lost through confusion or lack of traffic capacity at certain points along important highways.

The value of a trunk-line highway is generally in proportion to its length, provided it is well improved throughout. There are cases where an important state highway has been improved for long distances on both sides of a town and up to its corporate limits, but the town is not disposed to undertake a similar improvement of the portion of the road within its limits. The state may have the right to, and in equity it should, bear a certain portion of the expense, this portion depending upon the width at which the highway is to be improved through the town as compared with the width of the part outside of the town, but there may be no way of compelling the town to do its part. The result may be a delay of years in the realization of the benefit which would result from the complete improvement of the road.

State Should Have Power to Build Through Towns

It is probable that many of the state highway laws determine the proportions of the expense of improving such a link in its road system, which should be borne by the state and the town, but there may be no means of securing prompt action by the town authorities in providing its share of the funds. Such laws, where they exist, are necessarily uniform and inelastic; but even this is better than would be the practice of enacting special laws to fit each case. This would result in endless log-rolling, unfair compromise and grave abuse. It is difficult, if not impossible, to standardize where conditions are quite different. Prompt improvement of the entire trunk highway is the object to be sought.

The state should be able to secure this result, but without injustice to communities where the imposition of the share of the cost determined by statute would involve serious hardship. It would seem as though the power to carry out such improvement at the time other sections of the road are improved should be vested in the state, and that the town should be obliged to contribute such share as may be designated by law, with the right of appeal to some high judicial body which would have the power either to decrease or increase the proportion fixed by statute, after careful considerations of all the circumstances.

This suggestion may be somewhat crude, but it is put forward in the belief that the conditions which it is designed to meet are a serious obstacle to the prompt realization of a complete scheme of state and national highway improvement, and also in the belief that the value of such a system is dependent in no small degree upon the promptness with which it can be wholly completed.

Sources of Supply of Unskilled Labor for Highway Work

Committee Report by Chairman Paul D. Sargent
Chief Engineer, Maine State Highway Commission

After correspondence with members of your committee, it seemed advisable to approach this question from three directions: First, to learn if possible the condition of the unskilled labor market in the years immediately succeeding the close of the Civil War; second, to make a limited survey of labor conditions as they have affected highway work during the past few years and attempt to estimate probable labor conditions during the coming season; third, to get such information from the United States Department of Labor as has a bearing on this question.

Meager statistics contained in a letter of Charles B. Baldwin, acting commissioner of labor statistics, under date of Jan. 30, 1919, gives all of the information which your committee has been able to obtain concerning labor conditions after the close of the Civil War. This letter shows that while conditions were not good, times could not be called hard, and business remained good until the panic of 1873. Little unemployment was reported.

A questionnaire was sent out to all state highway departments, to the city engineers of all cities having a population in excess of 100,000, and to many of the large road-building contractors throughout the country.

The questionnaire asked for information as to the number of hours for a day's work, the rate of pay per hour for common labor from 1912 to 1918, and what would be the probable rate for common labor for 1919, 1920 and 1921. Inquiry was also made as to the apparent available sources of supply of common labor for the present season; as to additional sources of supply, if there did not appear to be a sufficient supply in sight, and whether state labor exchanges had been used where established, and with what result. It concluded by asking for information as to the number of common laborers required for construction work during the season of 1919.

Replies from Three Sources of Information

From the replies, which have been tabulated, we extract the following information:

Replies from State Highway Departments—Thirty-nine state highway departments made replies to our questionnaire. As some of the departments are only two years old, we have not used their replies in figuring average rates of wages.

In 1912 the average rate per hour as reported by 27 states was $0.188, while in the same year Georgia was paying $0.09 and Nevada was paying $0.40. Only six states were paying $0.25 or more, and 10 states were paying $0.15 or less—most of them less. In 1913

the average, as reported by 28 states, was $0.20. In 1914 the same states reported an average of $0.205, in 1915 of $0.225, in 1916 of $0.2585, in 1917 of $0.303 and in 1918 of $0.39. The highest rate for 1918 is reported by Oregon at $0.58, while the lowest is by South Carolina, at $0.18 per hour.

Twenty-seven states reply to our question as to probable wages in 1919. The average of these replies gives a rate per hour of $0.352; which, compared with the average of $0.39 for 1918, shows a slight decline. Fifteen states think the rate for 1921 will be slightly less than in 1920.

Thirty states think labor supply will be more plentiful in 1919, 1920 and 1921 than during the past three years. Twenty give as their reason the ending of the war with return of soldiers, closing of war industries and munitions plants, stopping of shipbuilding, etc. Seven states report an oversupply of labor now.

Fourteen states have state labor exchanges. Five states have obtained labor through these exchanges, but only three report good results. Twenty-eight states estimate their requirements of common labor for 1919 as 160,900 men.

Replies from Cities—Fifty-four out of 82 cities have replied to our questionnaire. Forty-six furnish information as to wages for all years from 1912 to 1918. Taking the year 1912, Spokane, Wash., reports $0.375 per hour, which was the highest, and Birmingham, Ala., with $0.14, was the lowest, while the average rate for the year was $0.234. In 1913 these 46 cities report an average wage of $0.238 per hour. In 1914 the average was $0.245, in 1915 $0.255, in 1916 $0.276, in 1917 $0.312, in 1918 $0.384. Boston, Mass., reports the highest rate for 1918, at $0.525 per hour. San Antonio, Tex., had the lowest for the year, $0.25, while Atlanta, Ga., and New Haven, Conn., both report a wage of $0.28.

Average Wage and Supply of Labor

The average wage which 48 cities expect to pay in 1919 is $0.384, which is the same as the average for 1918. Forty-two cities expect labor to be more plentiful this year than last, and 28 of the cities give as a reason the termination of war, the closing of war industries and the return of soldiers. Sixteen cities report plenty of labor now and in sight. Only two cities suggest additional sources. One New York city thinks immigration should not be prohibited, and one California city suggests Mexican labor. Three cities have obtained labor from state labor exchanges with good results; seven have had poor results with such labor.

Thirty-nine cities report that they will need 19,160 laborers during the season of 1919. Forty-three report that they will spend $46,570,613 in highway and street work.

Replies from Contractors—Twenty-four contracting firms, well distributed throughout the country, make replies which may be summarized as follows:

The average rate of wages they paid in 1912 was $0.192; in 1913 it was $0.20; in 1914, $0.21; in 1915, $0.23; in 1916, $0.256; in 1917, $0.315; in 1918, $0.397. The average wage which they expect to pay in 1919 is $0.38.

Sixteen contractors expect labor to be more plentiful on account of the cessation of war activities and the return of soldiers. It is interesting to note that just half of these contractors suggest immigration as the source of further labor supply.

Nine contractors have used labor from state labor exchanges. Six report "poor" results; one reports "bad" results, and two state that results were indifferent.

Information from United States Department of Labor

Through its employment offices distributed throughout the country, the Department of Labor has kept close tab on employment conditions, beginning soon after the signing of the armistice, and the number of cities reporting unemployment has been growing weekly. From Otto T. Mallery, executive secretary of the War Labor Policies Board of the United States Department of Labor, it was learned that this board is rather apprehensive of a serious condition of unemployment. The director of the board, Harold G. Moulton, concludes that, during the next 12 months, it is probable 5,000,000 or 6,000,000 workers will seek employment in this country.

As many of the industries which would under peace conditions absorb these laborers were dismantled and refitted for war work, and as many new plants were built in the early months of the war and fitted for war work exclusively, and will now have to be refitted for peace-time production, it is apparent that there may be some hiatus in employment, unless public works of a large volume can be provided to consume this labor during the process of transition.

It is interesting to note, in a recent report of Mr. Mallery, the following list of activities suggested for providing employment for surplus labor: (1) Highways; (2) forestry; (3) water conservation and control; (4) health; (5) public works of cities and towns. Note that highways are placed first. The following explanatory statement is interesting:

"Highway construction is particularly useful in providing employment for unskilled workers, upon whom the greatest burden of suffering falls in bad times. The geographical distribution of highway work is another element of advantage for our purpose, because it will diminish unemployment in many districts at the same time." Mr. Mallery states that the road builders of the country should rest assured that plenty of common labor for all highway construction work will be available during the present season, and from its investigations your committee concludes that the 1918 wage rate will be slightly lowered.

Vitrified Brick Construction for Heavy Motor-Truck Traffic

By Major W. M. Acheson
Division Engineer, New York State Highway Department

Brick pavement construction since 1915 has been subject to far greater changes in design than any other type. These changes, through a more rational use of the same amount of material, have tended to greater strength and durability. Engineers are now giving special attention to the various details of the

pavement, such as a foundation, a bedding course, and a wearing surface, in order to meet the existing conditions due to heavy motor-driven traffic.

In present practice, the foundation course is usually made of cement-concrete, of proportions from 1:2½:5 to 1:3:6, the thickness depending largely upon the character of the subsoil and the amount of traffic. While cement-concrete foundations predominate in brick pavements, many miles have been laid on foundations of compact sand, gravel and broken stone. However, engineers will agree to the absolute necessity and economy of concrete in the foundation for brick and all types of block wearing surface, together with mixed types of bituminous pavement. In fact, the time is here when highway engineers are called upon to design rigid types of construction. Too great care cannot be exercised in the proper design and construction of the foundation.

Sand cushion was originally intended to serve the double purpose of providing a uniform bearing for the wearing surface and a resiliency to absorb the impact of traffic However, it has been found impossible to obtain uniformity, even though this bed was reduced from 2 to 1 in., due to the variation in moisture content and thickness, which causes unequal shrinkage, thus defeating the function of providing a firm, uniform bearing for the wearing surface and causing failure under heavy traffic. Another defect is that the sand cushion works up between the joints of the brick, thus preventing the proper penetration of the filler. It is the opinion of the writer that the day of sand cushion for grouted surfaces has passed.

Brick Pavements of Semimonolithic and Monolithic Construction

To overcome these difficulties, which all precautions in laying the sand cushion have not sufficed to eliminate, the laying of the bricks upon a cement-sand bed, known as semimonolithic, or upon a green concrete foundation, which is known as monolithic, has been resorted to.

In the semimonolithic type, the proportion generally used for the bed is three parts of sand to one of cement. It is the practice to machine mix these materials while dry. In spreading upon the base, care should be taken to get uniformity; but hand rolling is not deemed advisable as it makes too dense a bed, and it is hard to obtain a smooth surface by rolling. The thickness advocated is a minimum of ¾ in. and a maximum of 1 in. Immediately preceding the grouting of the brick surface, the bed should be thoroughly saturated with water.

Brick pavements with cement-sand bed were built at Baltimore as early as 1906, and adopted as the city's type of construction in 1915. It was used in Jacksonville and also in the ramps of the Pennsylvania R.R. station in New York in 1910. (See *Engineering News-Record* of Feb. 20, 1919, p. 378.)

With present methods the semimonolithic type is better adapted to wide streets than is monolithic, but where widths are not over 24 ft., so that a templet may be used to shape the entire crown, the monolithic type of construction may be used. Proper consistency of concrete foundation is essential for this class of construction, and care should be taken to spade properly and distribute the concrete to prevent waves in the finished surface due to the difference in density. The foundation is spread usually ½ in. thick and formed by using a tamping templet, which brings the mortar to the surface, thus forming a bed for the brick. A mechanical templet has been developed which consists of a gasoline engine mounted on a cross-frame, with wheels which rest upon the side forms. This power templet performs the double purpose of tamping and smoothing the concrete, giving it greater density. It moves at the rate of 4 ft. per minute and can be adjusted to various widths. For rolling the wearing surface of the monolithic type, the use of a hand roller about 30 in. long, 24 in. in diameter, and weighing from 600 to 900 pounds, is advocated.

The advantage of these monolithic types of construction is that they overcome defects of the sand cushion, insuring rigid construction. The cement-sand bed practically unites the wearing surface with the concrete foundation and assures a proper penetration of the grout, thus giving a perfect bond for the full depth of the brick.

Both of these types largely eliminate the hollow rumbling noise which is common with sand-cushion construction, and give a more economical and scientific design in that a stronger slab is provided with the same amount of material. The use of the monolithic type also permits of the elimination of the edging, thus reducing the cost.

Wearing Course

Monolithic types have tended to develop the use of paving brick of less thickness, which will result in more economy, one of the important features being the saving in transportation charges. There should also be an economy in the first cost, together with a saving in actual manipulation.

The standard paving brick of today is 3½ in. wide by 8½ in. long by 4 in. deep, laying 40 to the square yard. They are provided with spacing lugs of either the repressed or the wire-cut lug type, the latter having rapidly increased in favor with paving engineers and being now extensively specified. The fiber sides of wire-cut lug brick which are produced by the method of manufacture give a greater bond strength, the uniform lugs insuring a thorough and even penetration of filler and the square edges making it easy to obtain flush joints which do not cobble, thus giving a smooth wearing surface.

Two classes of joint filler are used to bind the brick units together, the cement-grout filler and the bituminous filler. The experience and observation of the writer are that the results from the cement-grout filler are superior to those with soft filler, and it is absolutely necessary in the modern semimonolithic and monolithic types of construction. The New York State specifications for cement-grout filler allow the use of one part cement to two parts sand when machine mixed, and one part cement to one part sand if hand mixed. Machine mixing is considered far superior to hand mixing, and is more economical.

Health Board Studies Pipe Corrosion in Buildings

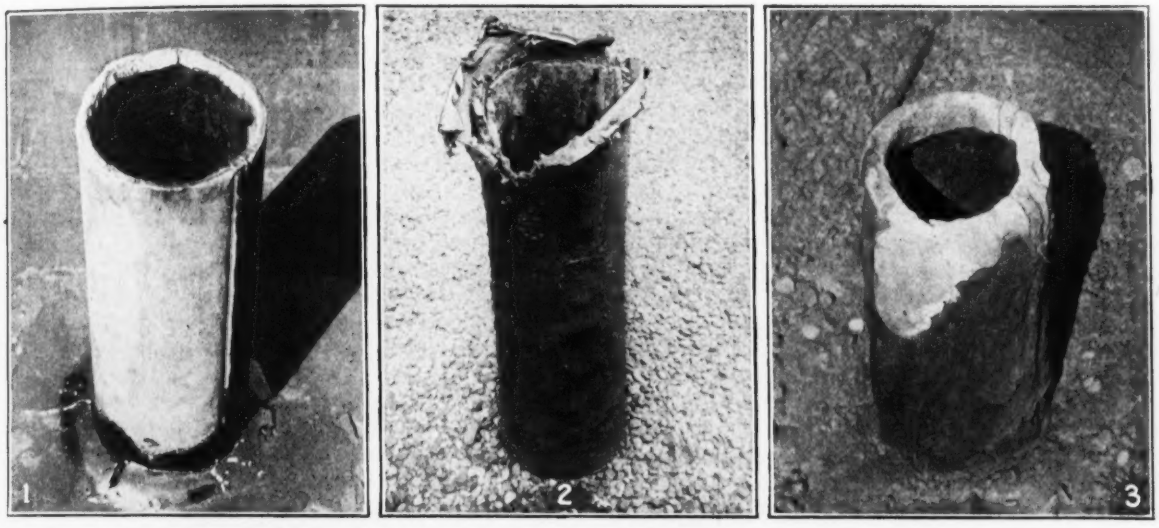
Cast-Iron Vents Have Long Life but Increasers Required at Roof Cause Rusting from Stoppages—Wrought Iron Preferable to Steel

EXAMINATIONS of sewer- and vent-pipe systems in buildings of various ages in the Chicago business district, made under the supervision of Thomas J. Claffy, assistant chief inspector of the sanitary bureau of the Chicago Health Department, have disclosed satisfactory service from black and galvanized steel pipe for a period of from five to 15 years. Wrought-iron and cast-iron vents in installations more than 20 years old are 20 and 25%, respectively, destroyed, while steel vents were 90% destroyed in the same periods. Mr. Claffy gave the information in a paper presented before the American Society of Sanitary Engineers, from which the following notes are abstracted.

It was the aim to examine buildings of six stories and higher, and more than five years old. In making this investigation the inspector was required to report on the height and age of each building; the number of vents at the roof line; the size of pipe and whether cast-iron or screw-joint; also to obtain samples of pipe and to describe such conditions as were found. Photographs were obtained of sufficient vents on the roofs to show an existing average of their condition. The inspector also was required to state whether the owner, superintendent, engineer or other person was interviewed. To distinguish between wrought-iron and steel pipe, it was necessary to take samples, filings being obtained of the clean metal for chemical tests, and pieces of the pipes for fracture tests.

Of 63 buildings investigated, 11 were less than eight years old, while 52 ranged between 10 and 30 years. Classified according to kinds of pipe used, 15 had cast iron; eight wrought iron; 19 steel; 11 mixed wrought-iron and steel; 10 cast-iron mixed with wrought-iron or steel. In the pipe systems more than 20 years old 33 roof terminals were of steel and were practically all destroyed; of 155 wrought-iron vents 17 were nearly destroyed, and of 218 cast-iron vents 43 were nearly destroyed. The relative estimated per cent. of destruction for steel, wrought iron and cast iron was 90, 20 and 25.

The poorer rating for cast iron in comparison with wrought iron is to some extent due to the probably higher average age of the cast-iron installation. The comparison refers only to destruction or near-destruction by corrosion, and does not take into account several dozen cast-iron vents which had clogged up with rust at the increaser below the roof and had thus become temporarily useless. Neither does it take into account the condition of the joints, which would further improve the rating of wrought iron over cast iron. The steel pipe was so completely destroyed by corrosion after 20 years as to exclude all consideration of joints or clogging which might be figured in its favor.



LEAD SHEATH PROTECTION ON VENTS SAVES OUTSIDE FROM COMBUSTION GAS CORROSION

Fig. 1—Galvanized steel vent seven years on City Hall scaling badly. Fig. 2—Black steel vent 16 years on the National Life Building crumbles in the hand. Fig. 3—Black wrought iron 27 years on Tacoma building is pitted as if by heavy sand blast

In buildings from 10 to 19 years old the large number of steel installations indicate how completely steel pipe, on account of its slightly lower first cost, has come into use in Chicago. On 101 galvanized steel vents 25% of the galvanizing was destroyed; of 144 black steel vents all were "scaling badly," and the depreciation was estimated at 75%. Of 28 wrought-iron vents, both black and galvanized were in "good" condition, the black being estimated at 10% "depreciation." All of the 13 cast-iron vents were in "good" condition, but with an estimated 10% "depreciation."

Galvanizing on the steel pipe appeared to be partly or wholly destroyed before the pipe is 15 years old, the pipe as a result lasting from 15 to 25 years before com-

plete destruction is observed. The relatively good condition of wrought iron, both black and galvanized, should again be noted, the 10% given for both wrought iron and cast iron indicating a slight depreciation but no actual failures.

Severe corrosion of steel pipe becomes evident even before the building has passed its first decade. Notable examples are the Cook County Building, 10 years old, with 34 steel vents, about half of them galvanized; and the City Hall, seven years old, with 42 steel vents, all galvanized but, in spite of this, all scaling severely. This does not support the claims concerning the improvement of steel pipe in recent years, according to Mr. Claffy, for, if anything, these new installations seem to be relatively worse than the older ones.

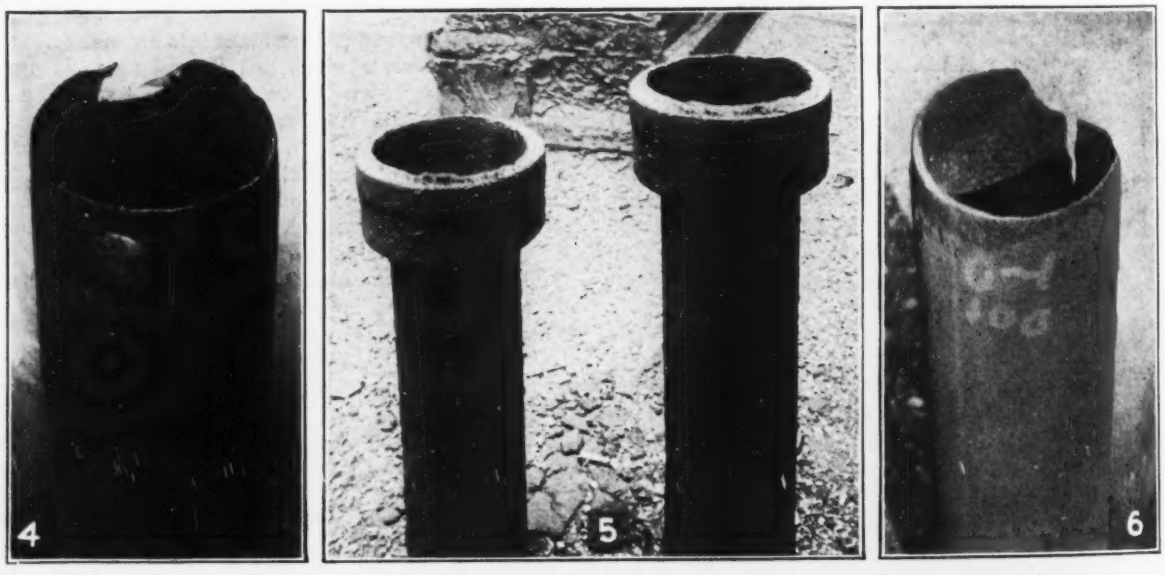
Although corrosion of drainage piping is severe everywhere, it appears to be about 50% worse in Chicago than in New York and other cities. Mr. Claffy attributes this largely to the fact that sewers are too small and remain full of water well beyond midnight, and the small-sized vents and wastes result in blowing out of trap seals and in siphonage of fixtures. The flat topography of the city, making possible only flat grades, tends to produce a septic condition and also accentuates the concentration of gases arising therefrom. This sewerage condition caused the main house trap to be abandoned long ago, the sewers and house drains being ventilated through the plumbing system.

If the destruction of the different pipes mentioned were confined to the roof line or the space immediately below it, there might be some grounds for believing that sulphuric acid gas from burning coal might be the destructive element. This, however, is not the case. In the Borland Building the soil, waste and vent pipes at the third and fourth levels were entirely rusted away, while the same lines of pipe near the roof were practically as good as when installed. In the Unity Building a wrought-iron waste line from urinals was rusted out entirely from the third floor up.

In the reconstruction of bath rooms in the Great Northern Hotel, about 10 years ago, it was found that the old system of waste and vent pipes was entirely destroyed at the threads and over practically the entire length of the pipe in many places. In other instances, drains hanging from the basement ceiling had rusted through and had to be replaced, and branch soil and waste pipes on intermediate floors were subject to the same deterioration from internal corrosion. For this reason, Mr. Claffy holds, it is clear that the agency causing corrosion is not from the atmosphere above the roof, but is due to the gases developed within the plumbing system itself and from the sewer in the street.

City ordinances in Chicago require the size of vents and soil stacks to be increased from a point directly below the roof to the top of the pipe, so as to prevent hoar frost from closing up the pipe in cold weather. Unfortunately, this causes rust and dirt falling down the pipe to find lodgment at the increaser, clogging up the pipe and defeating the purpose of the ordinance. This tendency to clogging is noticeable everywhere, even in cast- and wrought-iron pipe installations. The type of fitting now used as an increaser has a more gradual taper than that formerly in vogue, but the tendency to clogging can hardly be eliminated. The remedy would seem to be in the adoption of larger sizes of pipes, all the way down through the building, while if increasers are used they should never be over 1-in. taper. It would seem far better to have the hoar frost closing up the pipes for a few days in extremely cold weather than to have the pipes permanently clogged with rust and dirt.

From the standpoint of sanitation, one leaky pipe is as bad as another, regardless of what causes the leak, whether corrosion or failure from expansion and contraction. Many instances of leaky calked joints were observed, and unquestionably many escaped attention, being more or less inaccessible. Many joints also had been recalked, but it is a regrettable fact that leaky



EXPOSURE FOR THIRD OF CENTURY STILL LEAVES MUCH LIFE LEFT IN CAST IRON AND WROUGHT IRON

Fig. 4—Block wrought-iron vent 29 years on Bedford Building, although badly scaled and pitted, had to be cut with chisel for sample. Fig. 5—Heavy cast iron 30 years on McCormick Building only pitted deeply inside. Fig. 6—Medium or standard cast-iron vent on old Oxford Building cracked and pitted nearly through on one side

calked joints are not always readily discovered, and even less frequently repaired with promptness. In the meantime they permit the escape of gases of a noxious, if not dangerous, character. Unquestionably, from this point of view the screw joint is to be preferred, as long as it can be obtained without sacrifice of the necessary rust resistance of the pipe material.

If satisfactory service from black and galvanized steel pipe is obtained only for a relatively brief period of five to 15 years, and the ordinances do not differentiate between such pipe and wrought iron, Mr. Claffy believes that this is not playing fair with the public, which pays the bills. He says that the evidence against steel pipe is so indisputable as to admit of no contention. He is firmly convinced from what has been demonstrated in this investigation that there is a most decided difference between steel and wrought iron for such purposes as are necessary in a sanitary plumbing system. That fact should be recognized, and ordinances, laws or specifications should provide that steel pipe be not used in any buildings except those of a temporary character.

Arch Analysis by a Method Using Variable Elastic Weights

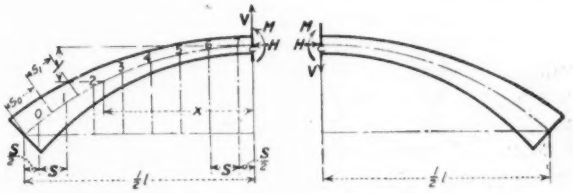
By Simplifying the Computation of the Summations Required, New Tabular Form Permits Rapid Solution of Arch Problem by Influence Lines

By F. J. Dulude
With J. G. White Engineering Corporation, New York

IN ANALYZING arches with fixed ends by the elastic theory, it is customary to divide the arch ring into a number of sections such that the ratio of the length of each section to its moment of inertia is a constant; i.e., the elastic weight, s/I is a constant. This method is open to criticism on the score of inaccuracy and difficulty of application, as it gives excessively long sections near the springing and unnecessarily short sections near the crown. Since the moment of inertia varies very rapidly near the springing and very slowly near the crown, it is evident that, from the standpoint of accuracy, this arrangement of sections is exactly the reverse of what it should be. Again, the points at which the bending moment must be figured are inconveniently spaced for ease of calculation, having no relation whatever to the location of the loads, especially in the case of arches with open spandrels. This makes it difficult to apply influence line analysis for moving loads.

The method presented herewith consists in finding the horizontal thrust, bending moment and shear at the crown for a load unity at any point, from which H, M and V for any system of loads can readily be found. When these unknowns at the crown are determined, the true equilibrium polygon can be drawn and the stresses at any section computed. By dividing the arch ring into sections with equal horizontal projections, as shown, accuracy and simplicity of calculation are obtained, as can best be demonstrated by reference to the concrete example which follows.

Tables I and II give the complete solution of H_u, M_u and V_u at the crown for a load unity at 15 points, including the crown. It should be noted that of the 22 columns in these tables, only 12 involve multiplication or division, and of these 12 only four—namely, 6, 9, 12 and 13—involve the multiplication of one variable by another, necessitating a separate setting of the slide rule for each line. Columns 14, 15, 17, 18, 19, 21 and 22 can each be obtained by one setting of the slide rule, being the product of a constant by a variable. Columns 4, 5, 7, 8, 10 and 11 are obtained by addition. Columns 16 and 20 are obtained by subtraction and columns 1 and 2 are obtained by scaling. Column 3, which is a tabulation of the variable s/I, involves computation which must be made in any event, no matter which method is used.



ARCH TREATED AS CURVED CANTILEVER BEAM

The example has not been solved beyond finding H, M, and V at the crown for live and dead loads, because when these are known the problem becomes statically determinate and further solution presents nothing new.

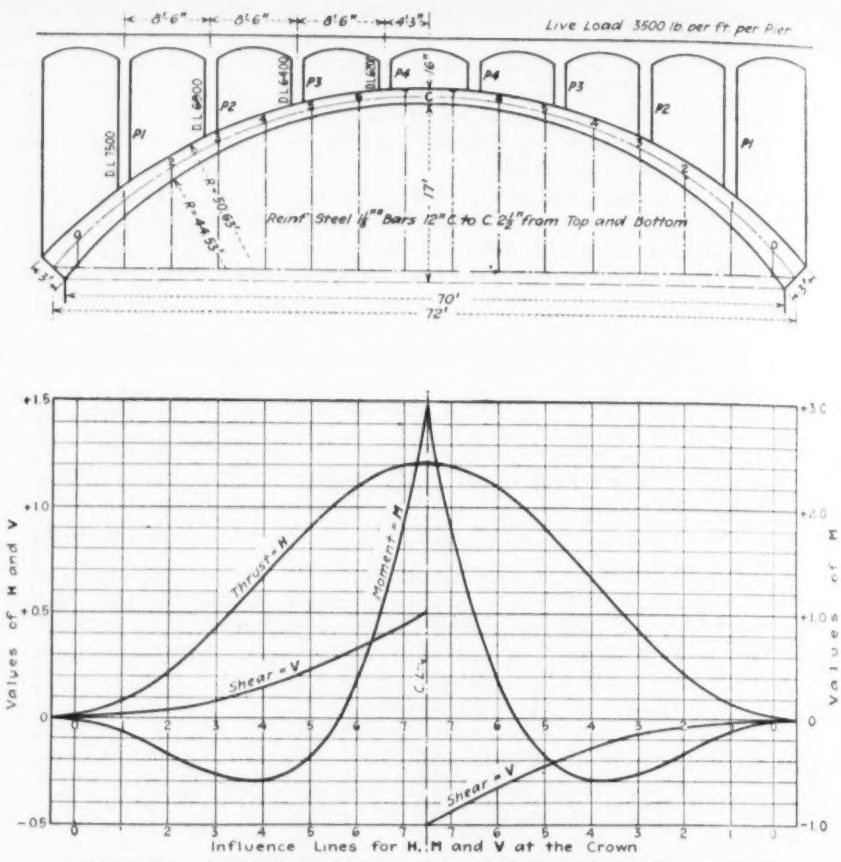
The notation and working equations, including equations 4 and 5 for temperature change, are as follows:

Let H, H_u, H_t be the horizontal thrust at the crown

TABLE I—COMPUTATION OF REQUIRED QUANTITIES

	1	2	3	4	5	6	7	8	9	10	11	12	13
	x	y	Δ	$\Sigma_0^n\Delta$	$[\Delta]$	$y\Delta$	$\Sigma_0^n y\Delta$	$[y\Delta]$	$x\Delta$	$\Sigma_0^n x\Delta$	$[x\Delta]$	$x^2\Delta$	$y^2\Delta$
0	33.75	14.3	2.95	2.95	0	42.2	42.2	0	99.5	99.5	0	3,360	603.0
1	29.25	10.2	4.36	7.31	2.95	44.4	86.6	42.2	127.5	227.0	99.5	3,730	453.0
2	24.75	7.1	5.41	12.72	10.26	38.4	125.0	128.8	134.0	361.0	326.5	3,320	273.0
3	20.25	4.6	7.95	20.67	22.98	37.0	162.0	253.8	161.0	522.0	687.5	3,260	170.0
4	15.75	2.8	10.90	31.57	43.65	30.5	192.5	415.8	171.8	693.8	1,209.5	2,705	85.5
5	11.25	1.4	12.85	44.42	75.22	18.0	210.5	608.3	144.5	838.3	1,903.3	1,625	25.2
6	6.75	0.5	15.91	60.33	119.64	7.9	218.4	818.8	107.2	945.5	2,741.6	725	4.0
7	2.25	0.1	17.85	78.18	179.97	1.8	220.2	1,037.2	40.1	985.6	3,687.1	90	0.2
0	.....	.....	.....	.....	219.06*	.....	.....	*1,147.3	.....	.....	*4,180.0	.....	.....
Σ	.....	0	78.18	.....	.....	220.2	.....	.....	985.6	.....	.....	18,815	1,614.0
		*179.97 + ½ (78.18)						* 1,037.2 + ½ (220.2)			*3,687.1 + ½ (985.6)		

due to live and dead loads, unity at any point, and temperature change respectively; M, M_u, M_t the bending moment at the crown due to live and dead loads, unity at any point, and temperature change respectively; V, V_u the shear at the crown due to live and dead loads, and unit load at any point, respectively; m the bending moment due to external loads at any point on either half of the arch considering each half of the arch as a cantilever, m_L for left half and m_R for right half; s the length of a division of the arch measured along the arch axis; I the moment of inertia of any section; $s/I = \Delta$ a variable having the value $\frac{s_0}{I_0}$ of pt. o, $\frac{s_1}{I_1}$ at pt. 1, etc.; x and y the coördinates of any point referred to the crown as origin; C the coefficient of expansion; T the temperature variation in degrees; E the modulus of elasticity of concrete; l the length of span, and S the horizontal division of span. M and V are assumed positive when acting as shown by the arrows in the diagram. Each half of the arch can then be considered as a cantilever subjected to exactly the same forces as exist in the arch itself; that is, the external loads, the reactions and the stresses at the crown represented by H, M and V. By applying the three fundamental equations of the elastic equilibrium to curved beams, it can be shown that:



SPANDREL ARCH OF 70-FOOT SPAN ANALYZED BY INFLUENCE LINES

$$H = \frac{\Sigma my\Delta\Sigma\Delta - \Sigma m\Delta\Sigma y\Delta}{2[\Sigma y^2\Delta\Sigma\Delta - (\Sigma y\Delta)^2]} \quad (1)$$

$$M = \frac{\Sigma m\Delta - 2H\Sigma y\Delta}{2\Sigma\Delta} \quad (2)$$

$$V = \frac{\Sigma(m_L - m_R)x\Delta}{2\Sigma x^2\Delta} \quad (3)$$

$$H_t = \frac{CTlE\Sigma\Delta}{2[\Sigma y^2\Delta\Sigma\Delta - (\Sigma y\Delta)^2]} \quad (4)$$

$$M_t = \frac{H_t\Sigma y\Delta}{\Sigma\Delta} \quad (5)$$

The summations $\Sigma m\Delta$ and $\Sigma my\Delta$ are for the entire arch. All other summations are for one-half the arch.

The only really troublesome terms in the above equations are $\Sigma m\Delta$, $\Sigma my\Delta$ and $\Sigma(m_L - m_R)x\Delta$. But it will be shown that, for unit loads, these three terms can be obtained by the simple process of addition. By dividing the horizontal projection of the semi-axis into any number of equal divisions, S, the points, 0, 1, 2, etc., are located by verticals at the center of each division.

Now consider a load of unity at any point, say 7 for example. Then $\Sigma m\Delta = m_0\Delta_0 + m_1\Delta_1 + m_2\Delta_2 + \ldots + m_6\Delta_6$;
but $m_0 = 7S$, $m_1 = 6S$, $m_2 = 5S$ etc.: Therefore:

$$\Sigma m\Delta = S[7\Delta_0 + 6\Delta_1 + 5\Delta_2 + \ldots\ldots + \Delta_6] \quad (6)\ldots.$$

similarly

$$\Sigma my\Delta = S[7\Delta_0 y_0 + 6\Delta_1 y_1 + 5\Delta_2 y_2 + \ldots + \Delta_6 y_6] \quad (7)$$

and

TABLE II—COMPUTATION OF H_U, M_U AND V_U

	8	14		15	16	17 H_U	18	19	20	21 M_U	11	22 V_U
	$[y\Delta]$	$[y\Delta]\Sigma\Delta$	$[\Delta]$	$[\Delta]\Sigma y\Delta$	$\frac{Q}{14-15}$	$S\frac{Q}{K}$	$S[\Delta]$	$2H_U\Sigma y\Delta$	$\frac{R}{18-19}$	$\frac{R}{2\Sigma\Delta}$	$[x\Delta]$	$\pm S\frac{[x\Delta]}{2\Sigma x^2\Delta}$
1	42.2	3,300	2.95	650	2,650	0.076	13.3	33	— 19.7	—0.126	99	±0.019
2	128.8	10,100	10.26	2,260	7,840	0.226	46.2	99	— 52.8	—0.338	326	±0.039
3	253.8	19,850	22.98	5,060	14,790	0.427	103.5	188	— 84.5	—0.540	688	±0.082
4	415.8	32,500	43.65	9,600	22,900	0.662	196.0	291	— 95.0	—0.606	1,209	±0.144
5	608.3	47,600	75.22	16,550	31,050	0.896	338.0	394	— 56.0	—0.358	1,903	±0.227
6	818.8	64,000	119.64	26,300	37,700	1.091	538.0	480	+ 58.0	+0.371	2,742	±0.328
7	1,037.2	81,100	179.97	39,640	41,460	1.195	810.0	526	+284.0	+1.815	3,687	±0.441
C	1,147.3	89,700	219.06	48,200	41,500	1.200	986.0	528	+458.0	+2.930	4,180	±0.500

$K = 2[(1614 \times 78.2) + 220.2^2] = 155{,}600$ $\quad S = 36/8 = 4.5$ $\quad 2\Sigma\Delta = 2 \times 78.2$ $\quad 2\Sigma x^2\Delta = 2 \times 18{,}815$

$$\Sigma mx\Delta = S[7x_6\Delta_6 + 6x_1\Delta_1 + 5x_2\Delta_2 + \ldots + x_6\Delta_6] \quad (8)$$

For simplicity, designate the terms inside the brackets in (6), (7) and (8) by $[\Delta]$, $[y\Delta]$ and $[x\Delta]$. Then, for example, $[\Delta]_7 = [\Delta]_6 + \Sigma_0^6\Delta$, etc., since if $[\Delta]^n = [\Delta]$ for a load of unity at point n; $[y\Delta]^n = [y\Delta]$ for a load unity at point n, and $[x\Delta]^n = [x\Delta]$ for a load unity at point n, it can be shown that, in general:

$$[\Delta]^n = [\Delta]^{n-1} + \Sigma_0^{n-1}\Delta \quad (9)$$

$$[y\Delta]^n = [y\Delta]^{n-1} + \Sigma_0^{n-1}y\Delta \quad (10)$$

$$[x\Delta]^n = [x\Delta]^{n-1} + \Sigma_0^{n} x\Delta \quad (11)$$

From equations (9), (10) and (11) it follows that $[\Delta]$, $[y\Delta]$ and $[x\Delta]$ for all points can be obtained by successive additions beginning at point 1, where $[\Delta] = \Delta_1$, $[y\Delta] = y_6\Delta_6$ and $[x\Delta] = x_6\Delta_6$.

For a load of unity at any point, then:

$$H_U = S\,\frac{[y\Delta]\Sigma\Delta - [\Delta]\Sigma y\Delta}{2[\Sigma y^2\Delta\Sigma\Delta - (\Sigma y\Delta)^2]}$$

$$M_U = \frac{S[\Delta] - 2H_U\Sigma y\Delta}{2\Sigma\Delta}$$

$$V_U = \pm S\,\frac{[x\Delta]}{2\Sigma x^2\Delta}$$

V_u is positive for the left half of arch and negative for the right half of arch.

The tabular forms of computation have been applied to the 70-ft. arch span shown. The time required, after facility is attained, will be considerably less than that usually necessary by the current method, using the determination of arch divisions to give constant s/I.

The value of dead load H is found in the usual way by multiplication of loads and H_u to be 40,860 lb.; similarly dead load $M = -1480$ ft.-lb. With live load on left half and P_4 right, $H = 12{,}450$ lb., $M = +4200$ ft.-lb. and $V = +1020$ lb.

Practicing Engineers Suggest Lines of Progress in Engineering Education

In response to questions similar to those sent to engineering educators, whose replies were published in our issues of Jan. 2, p. 41 and Jan. 16, p. 138, the following communications from practicing engineers indicate the directions in which engineering colleges should progress in order to satisfy the demands of those who are most directly interested in the ability and capacity of the engineering graduate. Among the suggestions made are: Arrangement of technical training into three classes—trade schools, general engineering schools, and post-graduate schools; postponement of specialization; immediate establishment of an education committee; experienced teacher-specialists, especially for freshmen students; more English in the first two college years; use of moving pictures; decrease in routine examples; more thorough knowledge of materials. There is also included a short abstract from a communication received from the dean of the University of Pittsburgh too late to be included in the educators' symposium; in this two general classes of education for the future are outlined. —EDITOR.

Broad Course Without Specializing Should Precede Graduate Work

BY JOHN D. ISAACS

Consulting Engineer, Southern Pacific Company, New York

THEORETICALLY, a complete education for an engineer is a broad college course, without specializing, followed by a post-graduate course specializing in engineering. This is about the way a well-prepared lawyer is educated, and there is no reason why an engineer should not receive the same education in order to prepare him thoroughly for a profession of equal importance. If so elaborate a course cannot be followed, the student should approximate it as nearly as feasible. For example, if the best that he can possibly do is a four years' course, then two years should be strictly general and the remaining two specialized.

In case of both the engineering and the legal student, there is an important psychological objection to a long course. During the educational period as above outlined, the character of a young man should be developing, and he should be acquiring self-reliance, independence and initiative, together with that general hardening and firmness acquired only by contact and competition with other men. But during this educational period he is usually dependent upon others for his living and subject to others for the direction of his conduct and mental energies. This leaves him in a somewhat helpless condition in beginning professional life and is, in part, an explanation of the slowness with which a graduate in any of the learned professions advances in making a place and reputation.

I should like to emphasize the distinction between a specialized education and a practical one. The former is theoretical, and the teaching applies to special branches of the profession. The practical education attempts to give current, practical details, shop methods and practice; detail drawing, etc. Except in a most restricted sense I do not believe in the second of these. The time of a young man at college is too valuable to be wasted on practical details which constantly change, and if he has any time to spare it should be devoted to broadening his course, and may be well applied to a study of literature or of the classics, for example. This much should be conceded, however, that all illustrative examples should be taken from conditions occurring in practice. As a rule, a young man having a thorough, theoretical education attains in the long run a higher position than one who starts with less theoretical but more practical knowledge, although the latter is the more immediately useful. There are exceptions, of course, but these are largely due to inherent qualities.

The rapid rise of the engineer in importance and the great demand for his services have placed his profes-

sion in the same category as regards influence and financial standing as that of the other learned professions, and will more and more give engineers of the coming generations the same opportunities for complete and thorough preparation, enabling them to achieve the highest success and to acquire the wealth and honors which go therewith. While such preparation seems long and laborious, and the opportunity for achievement slow in coming, the rewards are sure and worth the struggle and waiting.

Suggests Specific Subjects for Undergraduate Course

By A. P. Davis
Director, United States Reclamation Service, Washington, D. C.

UNDERGRADUATE engineering courses should, in my opinion, include the following subjects, mentioned in the order of time to be given them: Physics, including electricity and optics; mathematics and mechanics; chemistry; history of science; geology; rhetoric, including elocution and composition of reports; hydrology; physiology, hygiene and sanitation; organization and administration; business accounting; law of contracts; specialized subjects to be elected.

Instead of differentiation, courses should be largely elective, especially in the latter years, and many specialized courses should be added to the above general list for this purpose and receive proper weight and credit. The study of modern foreign languages should take the place of dead languages in a scientific or engineering course, but no foreign language should be compulsory.

Undergraduate work should be of a general nature, to lay a foundation for growth along special lines and to train the student in original research and self-culture. Such a course should require four years above the ordinary high-school course. The highly specialized subjects should mainly be left for postgraduate work and should be strongly interspersed with practical experience in field and laboratory and in shopwork.

The greatest weakness of American education is, I believe, a lack of thoroughness. There has been much improvement in this respect, and should be more in the future. The chief aim of the entire course should be to cultivate self-reliance, logical thought, skill in weighing evidence and in tracing effects to their cause, and, above all, to arouse interest in scientific facts and scientific research. Activity is an essential condition of growth, and mental growth along right lines is the object of education. The necessary activity should be along the lines of acquiring useful knowledge and practice.

Advocates High Degree of Specialization

By Virgil G. Marani
War Service Committee on Gypsum, Washington, D. C.

UNDERGRADUATE engineering courses should include a more thorough knowledge of materials used in engineering practice and an understanding of the process of manufacture of such materials. There should be included a course of instruction upon fire prevention and fire-resisting construction and materials, and upon the causes of the nation's present excessive fire losses and waste.

Courses should be differentiated. This is an age of specializing, and this thought should be carried out during the training of the engineering mind. Coördination should only be indulged in with reference to subjects that of necessity are common to more than one course, which is not a serious problem if engineering schools are patterned after universities. Each course should constitute a highly specialized unit upon one branch of engineering study alone, and extend over a period of not less than four years' continued application, with a shorter summer recess than is customary, or the summer months should be occupied by attention to carefully planned practical application of certain theoretical studies.

The greatest weakness in modern methods of teaching is the lack of practical application, with too much time and attention given to hair-splitting theories not necessary when the graduate launches into actual practice. In many cases engineering educators have sufficient knowledge to teach, but are woefully lacking in actual, practical experience. There are many cases of educators teaching hydraulics who have never had experience in the actual installation of water-works. The same may be said for sanitation, electrical engineering and similar studies. The best instructor is the one who enters the field of engineering for a period of years, and upon his reputation and success during these years obtains a professorship and teaches the subject for which he obtained his degrees and in which he has gained later his practical experience. Many universities will promote an honor graduate to a position of instructor and finally a professorship, placing upon him the responsibility of teaching engineers, when without practical experience he is totally unfitted for such a task.

Broad General Courses Should Treat Fundamentals Thoroughly

By M. M. O'Shaughnessy
City Engineer, San Francisco, Cal.

PRESUMING the student has creditably followed the high school curriculum before entering college, I believe his first two years could be profitably spent in surveying, drawing, advanced mathematics and mechanics, physics; chemistry, theoretical and practical; geology, mineralogy, and materials of construction. The courses for all branches of the art should be identical for two years, and no specialization should be permitted until the student has opportunity to measure up his inclination and ability.

I am in favor of a broad general course for at least three years and believe better results will be obtained in this way than by following highly specialized, restricted courses. With the normal boy who has passed successfully his high-school course, say at the age of 18, I believe the college should equip him in three years with the general fundamentals. If he desires to specialize and shows great proficiency in some particular branch, he can then develop himself either in outside practice or advanced college studies, at a later date.

The greatest weakness in the engineering colleges lies in the tendency for the principals to delegate too many

of their duties to juniors. There is also seen a tendency to load the boys unduly with routine examples which often keep them busy until midnight and exhaust their vital energies. I believe the heads of departments should not keep in a state of isolation from juniors, but mingle freely with them and give them the advantage of human sympathy and interest. Very often the slow, plodding boy is discriminated against in favor of the showy and more energetic, whereas in the real test of outside experience very often the greatest advances are made by the slowest boy.

I believe the greatest headway can be made in our engineering education by teaching a number of the fundamental subjects thoroughly and not scattering useful energies wildly on too broad a horizon.

Greatest Past Weakness is Lack of Teacher-Engineers

By John S. Crandell
New York City

THE average student does not know why he takes any particular course. For several years Prof. J. R. Lapham made it a practice to inquire carefully of freshmen why they had chosen civil engineering. The replies were astonishing. A large percentage replied, "Because the surveying instruments looked so nice." Many wrote, "Because father told me to." A great number, said, "Because it is such fine outdoor work." Not 5% had any well defined idea of the work of a civil engineer.

Freshmen need the most experienced and best teachers, for their minds are like twigs to be bent. Let the seniors handle the neophyte in the teaching profession; he will learn much. The freshman class should be carefully pruned; much dead wood removed, many saplings transplanted where they will do better. In fact, every college of size should have a Kathryn Blackford to sort out the human material and place it in the right files. New York University already has made a start in this direction.

Counsel from Experienced Minds

If the student does not know what he came to college for, and if his instructors make no effort to learn his natural bent, how can he be pumped full of specific knowledge? Under present arrangements we lead, push, entice, lure and haul him along a common highway until such time as he is assisted in making up his mind what he wants to do. That time usually occurs during vacation following the sophomore year. As a junior the student begins to have some aim in life. Here he needs counsel from experienced minds, from men who are as conversant with affairs outside the college walls as within, from professional "live wires"—and our colleges should be full of such men. If the student really likes engineering, let him be switched to the branch that interests him most. He may not stick to it after graduation, but that is of little moment. He will do better work in college at something he likes, and will train his mind to better advantage working over interesting problems than he will at something he dislikes.

Therefore, it is my opinion that all courses should be nearly the same through the first two years. During this time the student's mind is forming and is being formed. If nothing but English were taught during those two years the time would be profitably spent, provided the subject were properly taught. How many men are there who can write a really good business letter? How many men can write readable articles on their professional work? How many engineers can make addresses worth listening to? How many engineers have *you* ever heard give really stirring talks? Here lies the English field for engineering students; not the study of Beowulf and Chaucer, but the study of getting business with words.

Four years is long enough to fit a man to become an engineer. Highly specialized courses are for the post-graduates and the faculty members. The undergraduate has neither the inclination nor the ability to follow such work. His mind is not mature, and his social engagements prevent him giving the undivided attention necessary. Do not forget that youth will have its fling. The value of a college course is not measured by the number of logarithms a man commits to memory, but by the number of useful friends he gathers about him.

Greatest Weakness—Lack of Teachers

The greatest weakness of engineering schools is the lack of teachers. There are plenty of professors, an abundance of instructors, and multitudes of assistants. But there is, and always has been, a dearth of teachers. There are many excellent textbooks on the market, written by capable men, there are many well known names in the teaching profession, but, as Milo S. Ketchum said to me, "Too many faculty members know too little about the subjects they teach, and can't teach the little they know." The crying need is for men who can teach; men who are enthusiastic; men who are interesting as well as learned. How many of your own instructors were good teachers? Of mine I recall but three.

Teachers should be specialists. Specific knowledge should be required of them. Teachers should be selected, first, for their teaching ability, and second, for their intimate knowledge of the subject they are to teach.

But the greatest teacher of all is overlooked by every college in the land. The best and cheapest teacher, the teacher whose possibilities are unlimited, the teacher who interests, instructs, never wearies of work, and never needs a vacation, is all but ignored—the moving picture. Why have our educators failed to make the most of this truly wonderful teacher? Perhaps the extraordinarily successful experience of the Government in teaching soldiers by aid of the animated movies will awaken our college faculties. The era of teaching technical work by the moving picture is at hand. Let us grasp it *now*.

Two Types of Men Needed for Industries and Design Work

By F. L. Bishop
Dean, School of Engineering, University of Pittsburgh, Pittsburgh, Penn.

THE war has emphasized the need for two different types of men in the industries and in engineering design:

First, a man who may be called a technician, who is highly trained in science and mathematics, who pos-

sesses the instinct of the research man and who can devote his entire time to highly technical research problems, either in the research laboratories which are now rapidly being developed in the large industries, or by applying the results of his research to engineering science. For the training of this type of man there is needed the best of scientific equipment, the members of the faculty must be intimately interested in research problems, and the student himself must have what is sometimes called a mathematical mind. It is doubtful that this type of man can be developed in a four-year course, under existing conditions. In fact, it is probable that such a man can be developed only in a school which has a thorough graduate department devoting its energies primarily to research, but giving instruction in the fundamentals of science and mathematics.

The second type which seems to be demanded by the industries is the man who has a broad, general knowledge of engineering subjects, and can apply that knowledge in an effective way to present engineering problems. He must have the ability to command men, a knowledge of the applications of economic principles to industries, and a broad training in the so-called humanities, since he is the man in contact with men of other types in other fields of human activities. He should not be a research man, his training in mathematics need not be of necessity so extensive as that of the research technician, but his understanding of engineering problems must be extensive.

Such a man cannot be trained in the ordinary schools, because of the artificial conditions which of necessity exist in academic institutions. He must become familiar with the industries while yet a student, in order that he may understand thoroughly the applications of his theoretical courses in school and their application to industries, and also that he may become familiar, in the formative period of life, with the problems of labor and the human factor in engineering. It is in the development of this type of man, who is to become the manager and operating head of our large manufacturing industries, that, more than in the development of any other are needed the advantages to be derived from the coöperative system, which has been adopted at the University of Pittsburgh.

Proposes Education Committee of Engineers and Educators

By J. A. L. Waddell
Consulting Engineer, Kansas City, Mo.

After many years of deep consideration, I have concluded that the best possible arrangement for future technical training is: Trade schools for the rank and file of the profession, such as draftsmen, surveyors, inspectors and the lower grades of assistants in office and field; general courses in engineering for those of higher standing; and postgraduate courses for men of superior ability, energy and ambition.

In trade schools, during two or three years of 11 months each, the pupils should be taught elementary theory and the practical things which would quickly fit them to earn a fair living in a subordinate capacity at engineering.

In the general engineering schools there should be provided broad courses, fitting the students to become useful citizens and broad-gage men, drilling them thoroughly in mathematics and the general theory of engineering, and injecting into the course only enough of higher practice to illustrate the application of the theory that is being learned. This course should cover four years of 11 months each.

In the postgraduate schools should be given thorough instruction by experts in the combined theory and practice of all the special lines of engineering. This course, for any student, should cover not less than two, and preferably not more than three, years of 12 months each.

If the Herman Schneider, or coöperative, method of teaching engineering be adopted, five years of at least 11 months each should be utilized; and afterwards, if desired, any alumnus could take one or two years of postgraduate work in some of the higher branches of engineering.

Descriptive Instruction Necessary

General descriptive instruction should be imparted concerning the salient features of engineering construction and machines of all kinds, so that the student will know what his course is driving at, and so that he may be able to read understandingly and discourse intelligently concerning professional matters. He should learn in a general way how engineering structures are put together. For instances, in bridgework he should know how the metal is fabricated in the shops, and the different methods of erecting it in the field, also how substructure work is done under various conditions. In mechanical and electrical work he should learn how steam engines function and the operation of electric motors; and he should recognize the fundamental differences between direct current and alternating current and between the motors designed for their use.

All such primary ideas concerning practical engineering should be drilled into the student early in the course —preferably in the freshman year, but certainly not later than the sophomore year. He would be interested in securing all such knowledge; for the reason that it would appeal to him because of its utilitarian nature. Many a young man has dropped his engineering course after studying for a year or two almost exclusively mathematics and other subjects of which he could not perceive the practical application to the work of earning a living.

In schools that specialize in one main branch of engineering, there should be general courses in the other main branches—given, of course, with much less attention to detail. In schools offering full instruction in all the branches, it would be ideal to let the specializing be done entirely in the postgraduate course; but, unfortunately, only a small percentage of the alumni from the geenral course can be relied upon to take up postgraduate studies, hence a certain amount of differentiation is necessary. In my opinion, it would be well to confine this to the senior year, and under no conditions should it ever precede the junior year.

After the differentiation is begun, it would not do to let the students in the different lines attend the same classes for the purely technical work. For example, the

civil-engineering students would have to receive separate, special instruction in all subjects relating to electrical and mechanical engineering, the character of the said instruction being more elementary than that provided for the electrical- and mechanical-engineering students.

Weaknesses in Engineering Education

The greatest weakness in engineering education is the failure of instructors to arouse in the students an enthusiasm for the profession and a real liking for hard mental effort. Next comes the failure to teach the students how to study and to think, how to work efficiently, how to systematize and record, and how to read, write, and speak well the English language. The neglect to instill into the young minds the ethics of engineering is also a serious and almost universal fault in technical education. Business training is provided in very few technical schools. The *elements* of business should certainly be taught in the general engineering course; and the *science* of business should be given due consideration in the postgraduate course. Nor does the subject of engineering law receive sufficient attention in technical curricula, nor the allied subject of contract writing.

Engineering economics should be begun late in the sophomore or early in the junior year and continued until graduation, more and more attention being paid to it as the student advances in essentially technical studies. It is in the postgraduate course, however, that the greatest attention should be devoted to economics; for that should be the prevailing feature in all lines of engineering investigation—and it is of investigations that postgraduate work should largely consist.

To insure the most rapid development in the engineering education of the future, there should be appointed at once, preferably by the Society for the Promotion of Engineering Education, a committee of eight, consisting of four professors of engineering and four practicing engineers, in order to study the question thoroughly and report thereon. All of these men should be adequately paid for their services; and to this end an ample appropriation of funds should be made by Congress, because the immediate improvement in technical education is a matter that is of vital national importance.

These appointees should represent the various lines of engineering; they should be chosen solely for their experience, energy and special fitness. The final report should be made as truly thorough and far-reaching as possible, regardless of expense. Urgency should be one of the prime considerations in its preparation, because the time to effect the desired improvements in technical education is *now*.

The special committee suggested should determine to what extent the Herman Schneider method of imparting engineering knowledge should be followed in the general engineering courses given in universities and special technical schools. That it is capable of splendid accomplishment has been shown beyond all doubt in the University of Cincinnati, but whether it should be adopted as the sole, standard method of teaching engineering in all the schools is a debatable point.

Some Pointers on How to Finish a Concrete Floor

Notes From a Practical Cement Finisher on Use of Screeds and Treatment of Aggregate and Surface

By William McGinnis
Cement Finisher, New York City

CONCRETE floor finishing is a trade and, like all trades, has its tricks. The difference between a good job and a bad one and between a profit to the contractor and a loss often lies in the way in which the practical finisher does his work. Some of the points which must be looked out for have been gathered here.

The setting of strips or screeds is very important. Care should be taken that they are set at a dead level and thoroughly blocked or braced underneath, so as to avoid sagging from the weight of the straight-edge during the process of screeding. In nine cases out of ten they are set in an improper or haphazard manner, through carelessness or perhaps an ulterior motive. Where this happens, sagging is inevitable. The floor as finished is not level and depressions are formed, for the time perhaps not visible to a casual glance but later appearing with attendant costs. For instance, during the first troweling the pressure of the float or trowel brings some water to the surface, which afterwards finds its way and trickles into the depressions, forming pools. By the time that these pools are very noticeable the finishers will have worked several yards away, and it would cause too much trouble or annoyance to remedy the defect, so it is passed over. Now, it takes hours in most cases—sometimes from six to ten hours, depending on the depth of the slab—before the water in those pools or pockets is thoroughly absorbed in the aggregate, and the result is that the finishers are obliged to "wait" before they can properly finish the floor, and, even then, they must work slowly over the depressions to avoid leaving "trowel marks," owing to the uneven surface.

Disadvantage of Using "Dryer"

Of course, the pools can be dried by an application of "dryer"—that is, a dry mixture of cement and sand or gravel, poured or laid in the depressions, to absorb the water. This is very often done, but necessitates walking over the fresh concrete, thereby causing other holes and disfigurements, which only retard the finishing, though the cost will be somewhat less than it would be if the finisher waits for the pools to dry out. In both cases overtime charges are common.

Where strips or screeds are properly set and are rigid, no depressions or pockets are left in the surface, and consequently the water in the aggregate is more evenly distributed, thus causing a uniform set. The finisher's trowel glides easily over the surface, "waiting" and extra work are eliminated, and the result is a great saving of time and money. Strips or screeds spaced about 12 ft. apart give the best results. The straight-edge should be about 15 ft. in length, thus allowing an overlap at each end, and should be of a strong, rigid, light wood of 2-in. thickness, for on heavy screeding or "pulling" it often becomes tilted.

and, if less than 2 in., will sag or bend from the strain of pulling, leaving the surface in a more or less rolling condition, which necessitates a second screeding and a consequent loss of time.

In "raw" finishing—that is, one-course work—the proper setting of screeds is, if anything, more important, as the screeding or leveling is heavy and laborious, depending on the aggregate. For instance, crushed rock 1½ in. or less in diameter, with its attendant mixture of sand, etc., can be screeded faster and more easily than rock or other material of a larger size. In finishing a floor of this nature, it is usual and necessary to scatter or apply a layer of dryer over the whole floor to assure a "working surface," and this is usually done when the finishers are about to proceed with the first troweling. This necessitates walking or laying boards over the fresh concrete in order to apply the dryer, causing depressions or holes in the surface. This is the wrong way; the dryer should be mixed beforehand, and, as the screeding progresses, it should be immediately applied evenly to a depth of about ¼ in. In this way it acts threefold: (1) It begins at once to absorb the water on the surface; (2) it eliminates subsequent walking over the fresh concrete, and (3) it saves time.

How to Treat Slag Aggregate

In "raw" finishing where slag is substituted for crushed rock or otherwise, it will result in a great saving of time if the slag is wet and thoroughly soaked for several hours before being mixed in the aggregate. It is a light material, and some particles are lighter than others, though of the same size. When the slag aggregate concrete is poured and screeded, if the slag is not wet down the lighter particles will persist in coming to the surface, where they will remain in spite of all efforts to submerge them, and the finishing becomes very tedious. When the finisher is floating and troweling, those particles have the same effect as trying to float marbles into a hard floor; they roll with the floating, scratching the surface, and very often have to be picked out by hand and cast aside. Again, the edges of the finishers' trowels are nicked and torn, and have to be filed or ground down, and considerable time is lost in the process. In trying to overcome all this, an extra heavy layer of dryer is required, although its success varies, in some cases requiring a second layer, thus consuming extra material and the time in mixing and laying it on the surface. Where slag is thoroughly wet and soaked before being placed in the aggregate, it absorbs a certain amount of water, thus gaining added weight, and is not so apt to appear on the surface, so it requires less dryer and less time in the process of finishing.

On floors previously left unfinished and which later require a top coat of cement mortar or wearing surface, either an acid or a cement wash is used, to assure the adherence of the mortar. Acid should be applied freely at least one hour in advance of the finish concrete pouring, but afterwards, and slightly in advance of this finish placing, the surface should be swept lightly to prevent an excess of water in the mortar. Cement wash should be applied only barely in advance. In pouring, the mortar should not be dumped or heaped at random about the floor, as usually happens, for in case of any excess of water this sets up a dam and creates "soft spots" which retard the finishing. It should be poured in a continuous mass, of an even consistency, somewhat in the nature of a thick paste, and raked always in the one direction. In this way "soft spots" are avoided and a uniform set is assured throughout.

In floors where squares are required, considerable time is occupied in the jointing operation. The smaller the squares the more joints are required, and the more time is consumed. In marking out or spacing joints the ordinary way is to measure out and make notches around the edge of the floor, after the first troweling. This is wrong, as it necessitates walking over the fresh material, and is a slow process. The economical way is to mark out chalk-marks on the walls or outside of the forms, before the material is poured, thus saving time and extra work.

The high cost of finishing cement or concrete floors can in many cases be attributed to negligence, or to a lack of knowledge on the part of those charged with responsibility. Every defect adds to the cost, and the right way is the economical way. To the causes shown in the foregoing others might be added, but all can be summed up in the words, "Faulty supervision."

Macadam Road Built by Red Cross Refugees in China

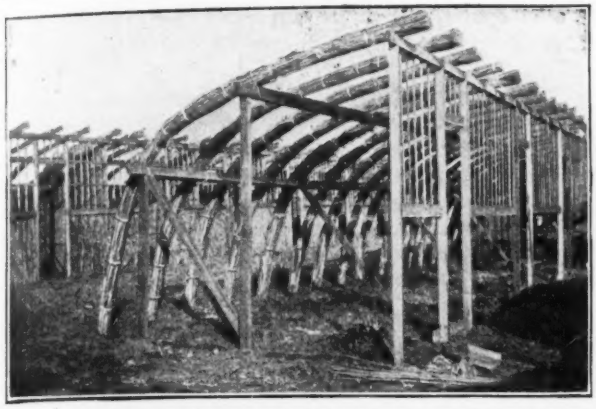
Granite Slabs of Old Road Used for Edging—Type of Camp Built—Macadam Stone Broken by Hand

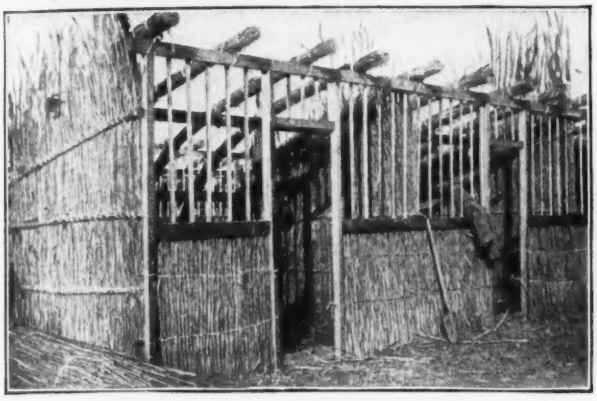
By R. A. White
Peking, China

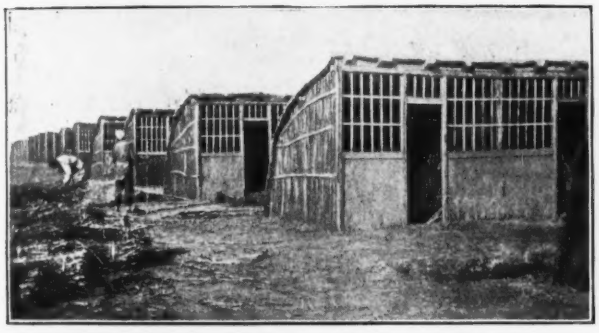
CONSTRUCTION of a modern macadam road to replace a worn granite-slab road has been effected in China by the use of Red Cross refugees. The old roadbed and materials were utilized as far as possible, and edgings 2½ ft. wide were built on each side, by the use of the old slabs which formed the existing surface. Metal for the new surfacing was produced by breaking the remainder of the old surface by hand sledging. Thousands of refugees were housed and fed in specially built camps by the Red Cross.

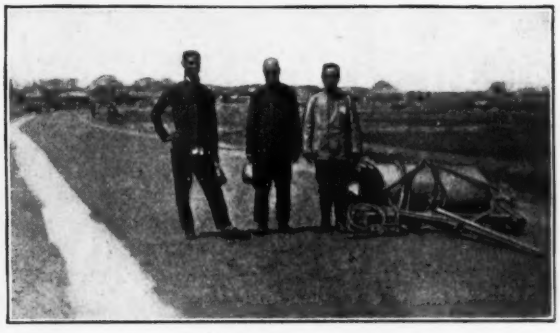
Late summer and autumn rains in 1917 caused the rivers of Chili Province in northern China to overflow their banks so that many thousands of square miles of rich farming country were flooded, and hundreds of thousands were made homeless. In some cases the water stood several feet deep, entirely destroying the 1917 crops, and when winter came the water had not yet subsided. To save the people, the American Red Cross of Peking, headed by the American minister, appealed to the Red Cross officials in America and received $50,000 in gold, with which a camp was built at Tientsin. This camp, which would house 5000 refugees, was built and filled with occupants in one month. The method of construction of these camps of Oregon pine framing and reeds covered with plaster is shown in the accompanying illustrations. Each one-room house, 9 x 10 ft., accommodated five persons.

Early in November, as the cold weather came on, it was evident that more help must be given. It was









CONSTRUCTION OF REFUGEE CAMPS IN CHINA

RECONSTRUCTION OF OLD SLAB ROAD IN CHINA

not thought advisable to build more camps, but rather to undertake some construction work, which would both benefit the refugees as well as be of some permanent value to the country. Accordingly, the American minister, Dr. Paul Reinsch, sent a second call for help to the American Red Cross, and this, combined with $100,000 paid over by the Chinese Government, made a fund of $200,000 which was set aside for construction work.

Considerable time was lost in deciding which kind of work to take up, but finally the writer, with George A. Kyle, chief engineer of the American railway projects in China, was asked to make a reconnaissance survey and estimate of a highway between Peking and Tientsin. It was found that the entire project, which practically followed the course of the allied march to Peking in 1900, would cost more than $500,000. It was, therefore, decided to construct immediately the section between Peking and Tungchow, a distance of 14 miles, which would afford work for 3500 refugees. These were soon recruited by local missionaries from the flooded areas adjoining Paotingsu. The men were a sorry sight upon arrival in Peking, for they had gone for weeks with little or no food and had very little clothing. It took several weeks to get them in shape for work.

Plans for the project were prepared by Mr. Kyle and the writer. Much thought and attention had to be given the viewpoint and stand taken by the Chinese officials that highways are the natural competitors of the railways. Due to this theory, one finds in China two cities of over 1,000,000 inhabitants, Tientsin and Peking, only 82 miles apart, and with only one single-track railway and an unused canal, long since fallen into decay, connecting them. Inasmuch as a through highway would be a natural competitor of the railway, according to the Chinese view, no highways connect the capital of China and the thriving port of Tientsin.

Tungchow, to which point produce comes by sea, river and canal from the entire country, had been connected with Peking by a granite-slab highway built

originally by the Ming emperors in the fifteenth century for transporting tribute grain overland. The highway was reconstructed during the 26th year of Chien Lung's reign, about the year 1750. Inscriptions on marble slabs placed on tortoise backs along the roadside describe how some 240,000 oz. of gold had been spent to benefit the country people in the neighborhood, in the building of this highway. It was 21 ft. wide with a curbstone set on each side, while the granite slabs were placed across the road and well embedded in a lime-concrete foundation, varying from 12 to 18 in. in thickness. The road was on a fill averaging 4 ft. high. The slabs were about 1 ft. thick, 2½ ft. wide, and varied in length from 4 to 15 ft. Continuous use of the road for centuries had worn ruts to such an extent that the road was practically useless for traffic.

Various stages in the construction of the new road are shown in the accompanying illustrations. The macadam section is 15 ft. wide, with slabs of granite on each side 2½ ft. wide to form an edging. The shoulders are of earth 4 ft. wide with 1 on 1½ slopes. In laying the slab-edging, the stones were set into the old lime foundations about 6 in., so as to avoid filling in with earth under the macadam, which was about 6 in. thick. The roller used to compact the macadam, the method of transporting in baskets supported on a pole carried by two men, and the stone-breaking yards along the highway, may be seen in the illustrations.

Refugees working on the roads were allowed a minimum monthly wage of $6.50 Mexican money, or about $5 in gold. Their food costs about $2.70 per month, and, after deducting this amount from the allowance, the balance is sent to the workman's family. Work was done on a piece-work basis, whereby they were paid an additional amount if the work done exceeded the minimum wage. The following prices, Mexican money, were paid:

Breaking ballast, per cubic foot	$0.04
Earth work, including ramming, per cubic foot	.04
Removing granite slab, per square foot	.02

It is purposed to have carts use the shoulder and granite edging, and as ruts are formed broken stone will be filled in. Metalled highways are not built, according to the official viewpoint, for the Chinese farmer or teamster, but for the nobility, who use rubber-tired vehicles. The carts mentioned have two wheels about 4 ft. in diameter with rims only about 1 in. wide and often carry as many as 20 pigs, the load weighing from 1½ to 2 tons. This type of wheel is ruinous to macadam roads, which will never be a success until the use of wide tires for the carts is made compulsory by regulation.

What the Government Did in Inland Waterway Navigation

Director General of Railroads Reports on Progress Made During 1918 on Waterways Taken Over By His Administration

GOVERNMENT control of inland waterway navigation was undertaken for the first time in 1918 by the United States Railroad Administration. Little actual progress was made by the end of the year, but such foundations for future work as were laid were outlined in the annual report of the retiring Director General of Railroads, W. G. McAdoo. That report, with the exception of the section relating to the New York State canals, which was presented in *Engineering News-Record* of Feb. 20, 1919, p. 370 is abstracted below:

Hundreds of millions of dollars have been expended by the nation, the states, and citizens for the purpose of developing our inland waterways and for the construction of canals. Thousands of miles of rivers, canals, lakes and bays are ready to assist in moving our products. These waterways, with the exception of the Great Lakes, are not being extensively used.

With the assumption of my present task, I appointed a committee to make a prompt investigation and to suggest a definite plan for the additional use of internal waterways, for the economical and expeditious movement of the traffic of the country, so as to relieve or supplement the railways under the conditions caused by the war. This was the beginning of a program which had been constantly pursued, and while the greater urgency for raw materials in war work interfered with the construction of steamers and barges, 160 steel, wood and concrete vessels are now building and 50 steel and wooden craft have been purchased. The total appropriation for old and new floating equipment exceeds $11,750,000.

The increased responsibilities of this country in the family of nations will demand greater commercial activity on our part. Transportation is a major problem, for, on account of the extensive area of our country, we have a longer average haul to seaboard than other industrial commonwealths. It has seemed to me evident that by developing transportation on the waterways and coördinating and articulating them with a unified railway system, we shall bring about a correct solution of the rail-water controversy, which has been in progress for 50 years. This is possible with the railways under Federal control. I doubt if any of our rivers or canals will become active factors in transportation if the railroads are turned back to private control. The old methods of railway competition with the waterways doubtless will be revived, and the waterway experiment may not be able to survive that competition.

Mississippi-Warrior Waterways

On July 11 there were created the Mississippi and Warrior Waterways, and M. J. Sanders was appointed Federal manager to have charge of the construction and acquisition of equipment for use upon the Mississippi River between St. Louis and New Orleans, and for use upon the Warrior River between the Alabama coal fields and Mobile, and in connection therewith for use upon the Mississippi Sound and connecting waters between Mobile and New Orleans, and to operate such equipment upon these waters in the Director General's behalf.

To establish immediately a water service on the lower Mississippi River was a matter of some difficulty, on account of the scarcity of suitable equipment. It was finally determined to purchase the fleet of the Kansas City-Missouri River Navigation Co., consisting of two towboats and nine barges, which, previous to the present season, was operated between Kansas City and St. Louis, Mo. The sum paid for this fleet was $458,500. No other suitable barges were available, with the exception of 20 steel barges in the St. Louis district, United States Engineers, that were used in revetment work and dredging. An arrangement was made whereby these barges were obtained under lease from the Engineer Department until June 1, 1919, together with two steel towboats. A third towboat was chartered from a civilian. There are now in service between St. Louis and New Orleans five towboats and 29 barges, the first sailing occurring from St. Louis Sept. 28. A weekly service is now being performed. Necessarily, there has been con-

siderable delay in the creation of joint tariffs and joint rates with the railroads, so that the operation has been restricted to such traffic as originates on the rivver banks, and also, because of war conditions, considerable decrease in north-bound business has resulted on account of the zoning of sugar. South-bound tonnage is largely composed of wheat and other cereals. The operation to the latter part of November, comprising five round trips, shows a total revenue of $48,500 and a total operating expense of $52,000, exclusive of overhead.

Authority has been issued for the filing of tariffs covering joint through rates between New Orleans and adjacent points taking the same rates, and points in northern Missouri, Illinois, Iowa, Wisconsin and Minnesota in both directions. These tariffs are now being prepared and will shortly be filed. The through rates reflect the differential of 20% between the rail rates and the water rates between New Orleans and St. Louis.

A terminal of considerable capacity is being erected in the City of St. Louis, and the terminal in East St. Louis has been purchased from the Kansas City-Missouri River Navigation Co. Arrangements for the use of ample terminals are being negotiated with the City of New Orleans.

The Director General has just authorized the construction of six large steel towboats and 40 steel barges (capacity 2000 tons each) at an expenditure of $6,170,000 for service on this waterway; estimated annual capacity, 850,000 tons. Operation on the Warrior River previous to this year has been irregular. Since the creation of the Missippi-Warrior Waterways Section the administration has purchased three towboats, 21 wooden barges, and six steel self-propelled barges for service between Cordova (near Birmingham, Ala.) and Mobile, Ala., and New Orleans, La. The cost of this equipment, after reconstruction and necessary repairs are completed, will be about $700,000. These vessels are primarily coal carriers and the annual capacity is estimated to be 300,000 tons. A portion of this fleet is now in operation.

Sufficient coal is produced from mines on the river bank in the Cordova district to employ the fleet constantly. The Director General has just authorized the construction for this service of four steamers to trade between the Birmingham district on the Warrior River and Mobile, Ala., and New Orleans, La., these ships to be designed to carry merchandise as well as coal—the total cost will be about $1,000,000; also, that three steel towboats and 20 wooden barges be constructed for coal service on the Warrior River. The cost of this equipment is estimated at $600,000; estimated annual capacity, 375,000 tons.

Delaware and Raritan Canal

This waterway, extending from Bordentown, N. J., to Raritan Bay, New York Harbor, being of limited draft and inadequate lock structures, had suffered a steady decrease in business up to 1918. It was taken under Federal control as a part of the transportation system of the Pennsylvania Railroad Co., to which it has been leased for many years past. Last year 272,734 tons were moved. It became evident early this season that there would be a very marked loss in tonnage due to the fact that coal was being shipped via other routes. In July the Division of Inland Waterways took charge of the floating power equipment on the canal and of the toll collections, and Dec. 1 the operation and maintenance of the canal was transferred to this division. The increase of tonnage over last year will be about 5%. The gain in the transportation of merchandise and high-class freight has more than offset the shortage of the movement of coal. The Railroad Administration has operated from three to 15 craft between Philadelphia and New York. The season is not completed, but it is apparent the ships, which were in all cases leased, will show a very small deficit, even after charging 10% of the expense of maintaining the New York office of the New York and New Jersey Canal Section to this service.

Chesapeake and Ohio Canal

This canal has been operated at a loss for several years. With the opening of navigation season of 1918 it developed that the Canal Towage Co., which operates the boats of the canal, was not attempting to engage in business. The traffic is almost confined to the transportation of coal, and, as the canal served particularly the needs of Washington and vicinity, the Railroad Administration regarded it important to preserve this utility, and entered into an arrangement to pay the toll charges on the boats of the Canal Towage Co. or any other coal boats. No other boats having appeared, this arrangement was later changed, and a new agreement entered into whereby the Railroad Administration guaranteed the towage company against any operating deficit. There was also authorized the construction of 10 barges to be used on this canal.

The tonnage moved in 1918 will be slightly less than the quantity moved in 1917, but the quantity moved to Washington and vicinity greater. There are two reasons for this: (a) A late opening and scarcity of boatmen, and (b) greater mileage per unit, resulting from the larger percentage of coal delivered to Washington and Indian Head. Although the accounting for the season's operation is not completed, it is apparent the operating deficit will be much less than the toll charges.

Intercoastal Waterway

An investigation was made of transportation conditions on that portion of the inland waterways between Philadelphia and Beaufort. This inquiry shows there is sufficient vessel equipment for normal seasons, and that the various barge companies have been and are building new equipment. There has been a lack of coördination between shipper and vessel owner. A number of vessels ordinarily used in this service has been under charter to the various military and Navy branches of the Government. These are being released to the owners.

The methods of handling freight on this waterway are out of date, and as the supply of labor promises to be somewhat improved, the efficiency of the present fleet, with modern terminal methods, should be increased 30 per cent.

In view of the fact that the projected locks and dams on the Ohio River between Pittsburgh and Cairo are not completed (the improvement has not been finished between Pittsburgh and Cincinnati) it does not seem a proper time to consider any new equipment for this route.

Broad City Planning Program for Pittsburgh

The newly organized Citizens' Committee on City Plan for Pittsburgh, of which C. D. Armstrong is president, has the following as its general program:

Conformity to definite plan of orderly development into which each improvement will fit as it is needed—not the immediate execution of the whole plan.

Saving in cost of public improvements by business methods—not waste through unnecessary or extravagant expenditures.

Encouragement of commerce and facilitation of business—not the obstruction of any trade activity.

The development of an American city worthy of civic pride—not an imitation of London, Vienna or Paris.

Conservation of human energy and preservation of life, particularly child life—not merely restrictive, but also constructive welfare methods.

Correlation of the city's activities—not haphazard changes with no adequate returns.

The proper application of art to municipal improvements—not extravagance, superficial beautification or vague attempts at civic adornment.

The rule of common foresight and prudence—not the rule of chance with ruinous expense and debt.

Preservation of historic buildings with their traditions—not the destruction of the old landmarks and city individuality.

Happiness, convenience, health, for all citizens—not merely expensive boulevards and parks for the few.

SOCIETY SERVICE

A Section Dealing with the Results of Teamwork by Technical Men

St. Louis Engineers to Engage Actively in Civic Affairs

The Associated Engineering Societies of St. Louis, with a membership of about 775, of whom 575 are in the Engineers' Club proper and the remainder in the local chapters of various national societies, are becoming active in civic affairs. At a meeting of the Engineers' Club Jan. 8 the following resolution was announced and passed:

"Resolved, that the Engineers' Club of St. Louis adopt the principle of taking a more active interest in economic, industrial and civic affairs."

At this meeting, also, the civic committee of the club was instructed to report on the need of a new state constitution for Missouri, on the possibility of issuance of state bonds for highway construction, and on the proposed issue of municipal bonds for public improvements in the City of St. Louis. In furtherance of the investigation and in view of the possibilities of state road construction, the club sent one of its members to the state capitol to attend the public hearing before the legislature.

Business Methods Put Speed into Road Association Work

Such marked success in handling a large amount of work was attained in a conference on rural concrete roads held Feb. 10-11 by the Mississippi Valley Association of State Highway Departments that the procedure is given below. For the discussion of various points the subjects were divided into 12 groups, each assigned to a committee, as follows: Grades and drainage; grades and pavements on culverts; widths of pavement and shoulder treatment for single- and double-track roads and state trunk lines; thickness and crown of pavement; alignment; widening and superelevation of curves; aggregates and proportioning; joints; reinforcement; handling materials from point of production to the work and into the mixer; preparation of subgrade and side forms; water supply; consistency; placing, finishing and curing in warm and cold weather respectively; testing of materials; field and laboratory inspection.

Six delegates were invited from each state, three from the State Highway Departments, and three engineers outside, also district engineers of the United States Bureau of Public Roads. Engineers of the Portland Cement Association attended at the invitation of the chairman, A. R. Hirst. Each delegate was assigned to serve on two committees. The first six committees met separately on the first morning of the conference and formulated their reports. As a basis for these reports there was in the hands of each member of the committee the recommended practice for concrete-road construction by the Committee on Concrete Roads and Pavements of the American Concrete Institute.

In the afternoon these committee reports were presented to the conference and there passed upon. The following day the remaining six committees handled in a similar manner the subjects assigned to them. The result was a large amount of work accomplished in a minimum space of time.

One of the chief objects to be accomplished was to agree as far as practicable upon the general practice for the construction of concrete roads in the Mississippi Valley states and to decide as to what this practice should be on points which were necessarily left open by the committee of the American Concrete Institute. So successful was this method of handling the meeting that it was the general sentiment that the future meetings of the Mississippi Valley Association would probably be arranged in a similar manner.

LETTERS TO THE EDITOR

Comment on Matters of Interest to Engineers and Contractors Will Be Welcome

Educational Training for Minor Engineering Positions

Sir—The recent correspondence in your columns relating to the education and compensation of civil engineers dwells on the subject mainly from the engineer's viewpoint. The viewpoint of the employer is equally important, for he holds the purse strings, determines the compensation and thereby fixes the standard which ought to be the basis for determining the expenditure of time and money it is wise to ask parents to approve as right for technical education. It is manifest folly to overeducate a man for his duties, unless the excess education calls for no parental sacrifice and fits the youth for a broader life.

The employer wishes to pay a fair market price for the engineer's work, but he sees no valid argument for paying more than that. He expects the price to be based on the quality of the technical knowledge required and the time consumed in performing the work. This is the basis of his payments for painting, for instance, for he expects to pay one price for whitewashing his cellar, another price for painting his house, another price for decorating the ceiling and walls of his parlors, and still another price for the preservation in oil and pigments, for the benefit of posterity, of those facial lineaments in which he takes a pride, more or less concealed. He knows what he should pay for such services.

But when, on the very few occasions he needs the help of a civil engineer, and he is without any measure by which to determine the fairness of the bills rendered to him, he notices that the work is actually done by men who are manifestly not paid highly by the engineers employing them. It is inevitable that he should endeavor to pay for such work about on the basis of house painting, for he cannot see that it calls for any greater skill, training or judgment.

In all the discussions of engineering education and compensation the point is overlooked that the requirements for the actual performance of the work to be done form the only basis on which arguments should rest. If the work is promptly, economically and well done, its actual value is not affected by the fact that the man who does it is an authority on municipal government, or able to read the New Testament in the original Greek or, on the other hand, is without training to do anything requiring greater skill and has no education to speak of. The employer is justified by every principle of economics in paying for that work only the minimum price necessary to have it done properly. If he wishes the work done by an expensive specialist who actually delegates it to a low-salaried employee, he has the right to have it done so, just as the great specialist has the right to charge only what the work is actually worth and not what he could earn by turning his attention to more difficult tasks. That men sometimes knowingly pay more than work is worth and charge less than they can earn at the most lucrative classes of work should not becloud the fact that the minimum price at which one class of work can be obtained regularly is the actual measure of value of that work.

Neither the education nor the compensation of civil engineers will be placed on a logical basis until the actual nature of the work done in civil engineering is dissected into its component parts, and the education and training actually required to perform each of these parts are conclusively determined. This means, not the superficial knowledge of history, languages, assorted sciences, literature, economics and the like, "without which no young man is fitted to take a responsible place in his profession," but the knowledge and skill actually needed to do that thing well. When such an analysis is made, it may be found that a very large part of the work done by engineers is really little more than skilled labor. Some of it may be highly skilled labor and deserve corresponding compensation, while part of it may call for no great skill and none of that ability in the direction of men and the reduction of costs which always has been and always will be highly paid because it is executive in nature.

It is debatable, to say the least, whether the present educational training for the engineer is not a questionable thing for the average young man to attempt, provided his circumstances are such that the time and money required for a complete course entail a serious sacrifice by his parents, brothers and sisters. If no such sacrifice is involved, such an education is an admirable thing; if the lad is certain to become a leader, the education is equally desirable; but how many of the thousands of technical-school graduates, educated at the expense of the greatest self-denial of their families, are earning today any more money or living any fuller and happier lives than would be the case had they gone to good trade schools and saved the years of study and hundreds of dollars spent in getting through a technical college?

One of the fundamental difficulties in this closely knit matter of engineering education and compensation lies in the common, wholly erroneous assumption that four years of technical school training superimposed on top of four years in a high school are necessary to train the average youth to perform the average work done in an engineering office. Every engineer in charge of a large office knows it is not true. Yet the young man who has been urged thus to spend these years of preparation has been assured that he must do it in order to carry on this average work, and his investment of time and money deserves a compensation commensurate with such a long educational training rather than the compensation he actually will get, based on the time really needed to acquire the requisite skill and knowledge in other places than a technical college.

Four years in a good trade school, run solely to give the training really needed under men inspired with an enthusiasm for teaching rather than a yearning for research, may be found just as helpful to the great class of young men who are perforce economical of both time and money. These men would go out to their engineering jobs without any of the feeling held by young graduates of technical schools that surveying, drafting, supervision of construction and the like very useful classes of work which do not call for special knowledge or executive ability deserve compensation at rates beyond those paid for similar attainments in other professions or callings.

In closing, attention is called to the very large class of technically trained men who leave engineering for contracting, manufacturing or commercial work. It is open to question if the eight years spent in high school and technical college have been a good investment for them. It is noticeable that they are generally young men with small means upon graduation, whose education has been a strain upon their families. The salary question is particularly serious to them. They have discovered that the greatest opportunities for capitalizing whatever technical knowledge they have acquired are in the competitive strife of energetic man-to-man endeavor rather than in the seclusion of a drafting office or the trackless wastes traversed by a surveying party. It is only this class which shows an inclination to speak disparagingly of present engineering education as the best system for all prospective engineers, but it should be noted that it is only this class which is not complaining about poor pay and lack of public recognition.

Upper Montclair, N. J. JOHN M. GOODELL.

Railway Bridge Impact Experiments Seventy Years Ago

Sir—Mr. Waddell's valuable contribution to the literature of impact on bridges in your issue of Nov. 21, 1918, p. 924, appears to me to give insufficient credit for the work done by the royal commission on iron bridges in 1849, and, as the work of this commission is almost invariably misquoted, I trust I may be pardoned for briefly stating the results.

The first experimental work of the commission was carried out at Portsmouth by James & Galton on cast-iron bars 9 ft. long, which were tested to destruction. Professor Willis enunciated the analytical problem and Sir G. G. Stokes obtained an approximate solution without periodic terms. He showed that his solution was equivalent to calculating the centrifugal force of the load. The impact effect in the Portsmouth experiments was found to be very great, and Willis showed that the experiments did not represent dynamical models of

actual bridges. The Portsmouth experiments did not, however, verify Stokes' analytical results, and the discrepancy was shown by Willis to be due to the fact that Stokes had neglected the periodic terms in his solution; in other words, the passage of a load sets up a vibration, and this vibration had been neglected in the analysis. Stokes then calculated the amplitude of the vibration and his results were then verified by Willis in a series of delicate laboratory experiments at Cambridge, using an ingeniously constructed dynamical model. Professor Willis shows in his summary of the investigation that in actual bridges it is only the periodic terms of the solution (the vibration of the bridge) that are of importance. The whole of this investigation neglected the effect of the periodicity of the load due to unbalanced masses.

The analytical work of Milan in 1893, referred to by Mr. Waddell, was principally the calculation of the centrifugal force of the load; i.e., the nonperiodic part of Stokes' solution.

C. W. LLOYD JONES,
Superintendent of Way & Works, His Highness the Nizam's Guaranteed State Railways Co., Limited.
Secunderabad, Deccan, India.

State-Insured Highway Construction Contracts Suggested

Sir—In your issue of Jan. 30, p. 257, there appeared under the title, "State-Insured Highway Construction Contracts Suggested," an article which states that it has been the custom of surety companies to provide contractors on state work with certified checks to submit with their bid. This erroneous statement is based upon the actions of a certain few political insurance brokers, who thought that by providing these checks they would corral all the insurance business, and also place the contractors under heavy obligations to them in other ways. It never was the custom of the surety companies to provide contractors with certified checks for bid purposes.

The article also states that large amounts of money have been paid to surety companies by contractors on state work, and that the companies have lost but little money on the payment of losses. The fact is that the surety companies have paid the state hundreds of thousands of dollars to cover losses. Some underwriters assert that the losses paid exceed the amount of the premiums received.

Many persons, engineers, architects and state officials, do not realize just what the contract bond is. They seem to think that a bond is like a policy of insurance, to cover all kinds of losses, which can be obtained by merely walking into the underwriter's office, laying down the premium and walking out with the bond. Instead, a bond is a three-party contract between the contractor, called the principal, the owner or the state, called the obligee, and the surety; and certain very definite obligations are placed upon each party and certain very definite rights given to each party.

The contract bond is a guarantee on the part of the principal that he will fulfill his part of the contract, and this contract is backed up by the surety company which is organized and operated under the banking and insurance laws. When there is a difference of opinion and a dispute between the principal and the obligee as to facts, the surety or bonding company can make payment on the bond to the obligee only after the dispute is adjusted, and it is determined that the obligee is entitled to recover. The high-grade surety companies have never refused to pay such losses. The surety bond is designated to protect the owner against a loss which he might suffer due to the unexpected and unforeseen contingencies that may (and frequently do) arise to cause even the financially strong contractor to default on his contract.

The hazard in writing surety bonds is so great, and the losses have been so big, that of 10 surety companies which were in businesss 10 years ago only four are now doing business. The others have either been forced to the wall or compelled to merge with stronger companies, by reason of the severe losses sustained on contract bonds. Road building, especially, has proved so hazardous that a contractor today, in order to obtain a bond on a road contract, must prove himself financially stronger and better equipped to perform the work than would be required for almost any other class of work.

There is little likelihood that the legislature would be induced to allow the state to embark on such a hazardous undertaking as the underwriting of contract bonds.

HARMON V. SWART.
New York, N. Y.

[Mr. Swart's letter was submitted to the New York Commission of Highways, and Mr. Morris, the secretary, replied as follows:—EDITOR.]

Sir—Your letter of Feb. 20, inclosing a letter from H. V. Swart dated Feb. 18, is at hand

The fact that highway contractors were provided with bidding checks cannot well be denied, in view of the volume and extent of the transactions; the openness with which they were carried on; the number of years the practice existed, and the knowledge generally possessed by all persons connected with the work in regard thereto. No claim has been made, however, that all participated in this practice.

I note that Mr. Swart says that surety companies have paid hundreds of thousands of dollars to the state on losses. I have no knowledge as to what payments have been made with regard to work other than highway improvement; the report of this department referred only to that class of work. As to highway improvement losses, however, it is a fact that from 1898 up to 1917 the records show that total payments by all surety companies for losses on forfeited contracts did not exceed $15,000; the premiums paid during that period for highway improvement work are understood to be something over $500,000.

Mr. Swart states that road building has proven so hazardous that the contractor to obtain a bond on that work must be financially stronger and better equipped than would be the case for almost any other class of work.

The insignificant amount paid during the period above mentioned is of itself an indication as to the lack of hazard. Highway improvement work is free from danger of fire, and, except in very unusual cases,

and even then to a limited extent, is free from any danger of flood. The work lies on the surface and there are none of the dangers of quicksand, cave-in and like hazards which are encountered in many other classes of public works. In short, where road contractors use due diligence in preparing their proposals and obtain contracts for reasonable prices, the danger of loss, under ordinary conditions, is reduced to a minimum.

I. J. MORRIS,
Secretary, New York State Commission of Highways.
Albany, N. Y.

Right-Hand Door Has Clockwise Swing

Sir—In answer to H. L. Conrad's query in your issue of Jan. 23, 1919, p. 201, regarding the swing of doors, I wish to say that one sure way of determining a right- from a left-hand door is as follows: Consider the hinge as the center of a clock; if the swing is in the same direction as the pointers then the door is right-hand, if opposite then it is left-hand.

Milwaukee, Wis. EMIL M. BUEHLER.

The Cost-Plus Contract a Success

Sir—Perhaps no single administrative feature that has ever been introduced into the engineering world has attracted more attention than the now famous cost-plus contract. It has been assailed from some quarters and upheld from others, but nevertheless has forced itself into notoriety and public recognition.

An agency so powerful as to disrupt the peaceful equanimity of commercial practice and line up the brains of America in bitter opposition on the one side, and in unqualified support on the other, surely merits a most thorough investigation and wide discussion, that out of the chaos of conflicting opinions may be builded a sound foundation for future development.

In every cantonment and camp in the United States, the Government maintains an officer in charge of construction, known as the constructing quartermaster. As constructing quartermaster for the building of Camp Frémont, near San Francisco, and now for Fort Sill, Oklahoma, it has been my privilege to supervise construction work amounting to over $3,000,000, under cost-plus contracts covering a period of 18 months.

The cost-plus contract is just as applicable to commercial practice as it is for Army use, the only difference being that under private direction the constructing quartermaster would be known as the supervising engineer. The cost-plus contract as used by the Government has three cardinal virtues: Absolute fairness, flexibility, and centralization of power. The most important of these is the centralization of power in the hands of the constructing quartermaster, or supervising engineer in private work.

Certainly, no fairer scheme was ever devised for both the contractor and owner. The profit is fixed in proportion to the expenditure. Additions to, or subtractions from, the work can be made at will. As unlimited power to direct the work is given to the constructing quartermaster, full and absolute responsibility for its proper execution rests with him. This point cannot be too strongly emphasized. There is no dodging responsibility. If the cost-plus contract has failed anywhere, it is due to the incompetency and mismanagement of the directing head. No orders for materials can be placed by the contractor without his approval in writing; no equipment can be purchased or even rented without it. He has complete authority to order the discharge of any member of the contractor's organization, from the manager down. If the contractor pads the payroll, if materials are ordered that are not needed, if wasteful methods are allowed, the responsibility can be undeniably nailed upon one person—the *directing head.* If the directing head is competent, the proposition will work "like a charm." The success of the enterprise hangs upon the choice of the field management. The trend of modern business methods is toward centralizing authority in one person, and then holding that person responsible.

After operating under its terms in closest detail for almost two years, I am so strongly impressed with its desirability that I believe a monument should be erected to the memory of the genius who invented the cost-plus contract. In spite of all that can be said in opposition, the unassailable fact remains that the Construction Division of the Army has accomplished the greatest building task ever undertaken in the history of the world, and has done it under the cost-plus contract; an accomplishment that will ever shine forth as one of the fairest jewels of the nation's diadem of glory.

J. B. CHAFFEY,
Major Quartermaster Corps, United States Army.
Fort Sill, Oklahoma.

Suggests Practical Method for Testing Truss Bridge Members

Sir—With reference to the matter of formulas for steel columns, dealt with in recent articles and letters appearing in *Engineering News-Record,* the writer wishes to take this opportunity of drawing attention to the fact that existing column formulas are not founded on really proper tests, and that therefore engineers should not rest satisfied until such proper tests have been made, and, from the empirical rules deduced therefrom, a really sound column formula has been evolved.

No column experiments have yet been made which conform to actual conditions existing in modern bridges, as very few columns nowadays have hinged ends, and flat-end tests are likely to be very deceptive, because of corner bearing.

The opinion expressed by Charles E. Fowler in his letter on page 343 of your issue of Feb. 13, 1919, to the effect that a straight-line formula is to be desired on account of its simplicity, is to be commended, as there is every probability that an exact straight-line formula can be derived from proper tests. It is to be noted that some of the formulas given by Mr. Fowler in his letter use the $(l/r)^2$, this being a holdover from the old Euler formula, which was established for greater values of l/r than are used in practice.

With reference to Dr. Waddell's scheme for testing top-chord members by means of experiments conducted on a specially-built full-size bridge, the writer begs to make the following suggestions for a practical method for making such tests: Build a single-track Class 70 through-truss bridge, with the weak member designed for, say, Class 40 loading, so that the destruction of the weak member could be accomplished without injury

to the rest of the structure, thus facilitating repairs for repeated tests. The connection plates for the weak members should be extra strong. After the compression tests are completed a series of corresponding tests on tension members should be made, so as to determine the real efficiencies of both tension and compression members, and their comparative strengths. Unless this kind of a test be carried out, we shall never have any really reliable test data, as the existing data are, to a great extent, misleading. It is advisable that more than one value of l/r should be tested for.

It should not be overlooked, in making up a design for a test structure, that there is a necessity for thorough detailing throughout, especially in connection with the weak members, so that failure will be in the form of a square break instead of being due to any insufficient detail, thus removing ambiguity. It would be advisable to build the permanent members of the trusses of the test bridge of nickel steel, so that the permanent and the weak sections would be somewhat alike, if the weak section were of ordinary structural grade of carbon steel.

The most satisfactory method of applying the load would be by means of hydraulic presses or jacks, to be applied at panel points, and all connected so that the load would be uniform. Pressure records should be automatically made. Control of the applied load by this means would be very simple and positive. It would be desirable to make tests for low values of l/r, so as to establish the necessity or otherwise for limiting intensities of stress.

Many of the tests we are relying on at the present time for our formulas were made on badly designed struts, and I venture to say that tests on properly designed struts would show up stronger than the present tendency of the profession in strut design indicates.

F. H. FRANKLAND,
Consulting Engineer.

35 Nassau St., New York City.

Regarding Details at Support of Pony Span in Cantilever Bridge

Sir—Replying to Mr. Godfrey's letter [see *Engineering News-Record* of Feb. 27, 1919, p. 441], the line of reaction of the rocker shoe is shown 5 in. from the intersection of the members supporting it, and this was subsequently changed to about 3 in. The offset was made for architectural effect and was considered justified since there was an excess of strength in the members adopted.

The section composing the tension members of the cantilever where the bend is made at the rocker consists of two 6 x 4 x ⅞-in. angles, two 8 x 8 x ⅞-in. angles and a 28 x ⅞-in. plate. The maximum stress is less than 7000 lb. per square inch of net section, and the inclination less than 1 in 9, which is not considered such a bad condition. There are two angles 6 x 4 x ⅞ in., two angles 8 x 8 x ⅞ in., with a ⅞-in. and a ⅞-in. plate on top to form a seat for the rocker, and all the rivets are ⅞-inch.

The writer agrees with Mr. Godfrey, in principle, that top-chord members should not be subjected to torsion, but fails to see any possibility of distorting the frame of the chord where its members are so heavy in proportion to the torque applied.

The bent plate at the connection of the lower member of the sidewalk bracket with the chord is a 15 x ¾-in. plate, and the stress is about 4000 lb. per square inch.

There is no tension in rivet heads in the connection of the sidewalk brackets at the pony span, as ⅞-in. turned bolts were employed.

L. W. METZGER,
Designing Engineer, Oregon Highway Commission.
Salem, Oregon.

Long-Time Mixing Should Not Reduce Strength of Concrete

Sir—I have read with considerable interest the letter of J. O. Jones in *Engineering News-Record* of Jan. 23, 1919, p. 200. In addition to the account of the very complete tests made by Prof. D. A. Abrams discussed editorially in the issue of Nov. 28, 1918, p. 966, the results of tests made by other investigators have been published from time to time. It is of special importance to note that without exception—at least so far as the writer has knowledge—these investigators have obtained results tending to confirm the finding of Professor Abrams and lacking accord with the results described by Mr. Jones. In this connection, the tests made at Purdue University (see *Engineering and Contracting*, Vol. XLIII, Jan. 27, 1915,) and those made by the Pennsylvania State Highway Commission, are of interest. Fig. 1 shows graphically the results of these tests.

Assuming the use of cement fulfilling the requirements of the A. S. T. M. specification for portland cement, it seems reasonable to assume that little, if any, impairment of the cement matrix of the concrete will result from mixing the ingredient materials 10 to 15 min. However, it is common practice to specify 1 to 1½ min. as the mixing period after all materials are placed in the mixer drum, one-tenth the time assumed above.

In a concrete mix the cement and a portion of the water combine chemically to form the cement matrix, which ultimately binds together the inert particles of the sand and stone aggregates. Since the cement is the only active, strength-producing material entering into the mixture, it follows that, apart from the physical properties of the aggregates, the strength of concrete is dependent entirely upon (1) the proportioning of the materials, including the water, entering into the mix;

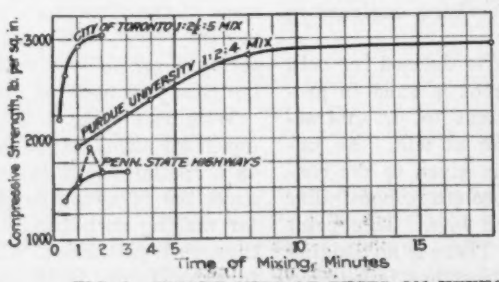


FIG. 1. THREE SETS OF TESTS ON EFFECT OF TIME OF MIXING ON STRENGTH

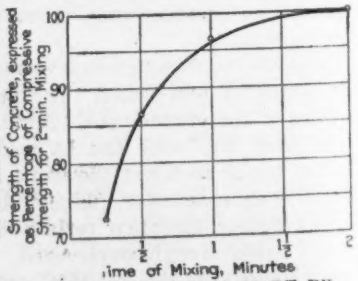


FIG. 2. TESTS MADE BY L. N. EDWARDS

(2) the thoroughness of the distribution of the cement matrix over the surfaces of the particles of sand and stone, and (3) the proper seasoning of the concrete.

The real object and purpose of mixing is the thorough incorporation of the component materials of the mix. The abrading action of the sand and stone particles moving upon each other during mixing is the most important factor tending to produce thoroughness of distribution of the cement matrix. It is commonly recognized by concrete makers that the "workability" of concrete containing sufficient water to produce a saturated, semiplastic mortar, adhering freely to the particles of stone aggregate, is improved by a comparatively long period of mixing. The writer firmly believes that the strength, toughness and durability of the concrete are also improved. Fig. 2, reproduced from his paper, "Effect of Grading of Sands and Consistency of Mix upon the Strength of Plain and Reinforced Concrete" ("Proceedings," American Society for Testing Materials, Vol. XVII) shows the relation of time of mixing to the compressive strength of concrete, as obtained in a very carefully made series of tests. In these tests a steam-operated Foote mixer of ½-cu.yd. capacity operated at the rate of 16 rpm. was used. All materials, including the water, were proportioned by weight.

The writer can offer no satisfactory explanation for the rather remarkable results obtained in Mr. Jones' tests. However, he is of the opinion that other factors influencing the strength of the concrete were perhaps not as carefully controlled as they might have been. Too frequently, in concrete-making operations in the field, the valves provided for gaging the water content of the mix are in bad order, and the leakage of additional water into the mixer drum during the mixing period is sufficient to offset the advantages which might be obtained by an increased period of mixing. In this connection it is worthy of mention that Professor Abrams' tests, as well as those of the writer, show that the addition of one pint of water to a one-bag batch of concrete in excess of that required to produce a "workable" mix is equivalent in its effect to the omission of 2 to 3 lb. of cement.

LLEWELLYN N. EDWARDS,
Supervising Engineer of Bridges.

Toronto, Ont.

What Was the Coefficient of Friction in the Calaveras Dam Slide?

Sir—The slide at the Calaveras dam under construction by the Spring Valley Water Co. of San Francisco, occurred Mar. 24, 1918, and was described in *Engineering News-Record* of Apr. 4, 1918, p. 679, by Allen Hazen and Leonard Metcalf. A report on the subject was also made on May 25, 1918, to the United States Reclamation Service by C. H. Swigart and the writer, which was published in the *Reclamation Record* for November, 1918, and in *Engineering and Contracting* for Jan. 8, 1919. In this report the conception of the authors of the relative position of various classes of material in the dam was described and illustrated, certain assumptions were made as to weights, and an approximate calculation was made of the forces tending to produce and resist sliding. Study led up to the following statement in the report:

> The rough conclusion which may be drawn on the basis of assumptions made is that a sliding factor of about one-half for the dry mixed rock and earth-fill used in the dam is safe, and that when this factor reached eight-tenths sliding took place.

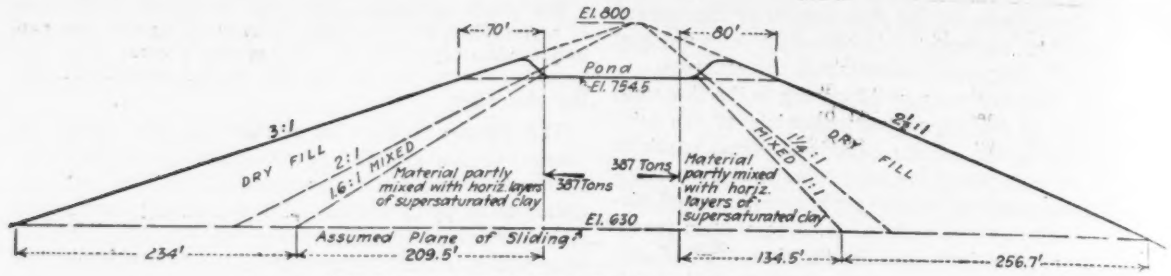
The Spring Valley Water Co. put Mr. Hazen in charge of designs for the completion of the dam. During the summer and autumn of 1918 he made an elaborate study of the materials remaining in the dam, and determined weights, water contents and stability upon which to base his conclusions as to reconstruction. He described the results of these studies in a highly interesting article published in *Engineering News-Record* of Dec. 26, 1918. Incidentally, Mr. Hazen referred in this article to the coefficient of friction of the moving material, saying, "From these figures the coefficient of friction for the whole mass at the start of the slip may be computed as 0.20."

The disparity of the values of the sliding factors 0.50 and 0.83 in the earlier report and the coefficient of friction 0.20 deduced in the later article was so striking as to attract the writer's attention at once. The investigations made after the date of the earlier report gave information which would permit revision and correction of previous assumptions, but this could hardly account for so great a difference.

A careful comparison of the respective conclusions made it promptly apparent that the values mentioned are not comparable. Mr. Hazen determined the *average* coefficient of friction for the entire base, whether consisting of dry material or slippery and partly supersaturated clay. The writers of the Reclamation Service report assumed that the wet-clay portion of the base offered very little resistance to sliding and figured all resistance as being concentrated on the portion of the base free from masses or layers of wet clay, which occupied only about one-third of the sliding base and which by reason of the flat water slope received even a smaller portion of the load. Thus they found a value more than three times greater as regards the reservoir side of the dam, which did slide, than the value found by Mr. Hazen as an average for the entire base.

The subject seemed of sufficient importance in connection with future design of dams with hydraulicked clay core to warrant restudy, and it was also deemed desirable to avoid possible confusion in the minds of readers of both articles, as to the coefficient of friction. The subject was fully discussed by correspondence with Mr. Hazen.

It may be remembered that the effort followed in construction, after it had been decided to use dry fill for the outer masses, was to place these masses as far as practicable in such manner as to have the clay core occupy two-thirds of the volume of the dam upstream from the center line and one-half of the volume downstream. This would make the clay core extend to the sloping lines 2 to 1 upstream and 1½ to 1 downstream, as shown in the accompanying sketch. This figure represents a section of the dam as originally designed, extending downward as far as the probable level of the plane of sliding, and showing in drawn lines the approximate condition of the finished work just before the slide.



SKETCH OF CONDITIONS IN CALAVERAS DAM SLIDE

In dumping dry material so as to cause it to project over the mud pond, a considerable amount of settling took place, producing a rising pond level at times when no hydraulicking was in progress.

In the writer's previous consideration it was assumed that this process of settling resulted in some mixing of materials along planes of contact, the dry material absorbing the surplus water in the adjoining and intermingling clay and producing practically water-tight mixed zones.

The width of these zones was never definitely determined. Such information as was available to the writer in May, 1918, led him to assume that these zones were comparatively narrow and that they were confined between sloping planes, as shown in the sketch.

The elaborate study given to this subject leads Mr. Hazen to conclude that penetration of dry fill into the liquid core was far deeper, and for all practical purpose extended clear down to the base. His conception is that the mixed mass was not homogeneous, but that it contained layers of pure clay supersaturated to an unknown degree, extending far out under the slopes and capable of transmitting hydraulic pressure.

As to weights of materials, the weight of loose fill deposited in 5- to 6-ft. layers, unrolled, was taken by the writer in May, 1918, at 90 lb. and of the liquid core of 83.3 lb. per cubic foot. Mr. Hazen found the weight of the loose fill to be 110 lb. per cubic foot dry and, as near as could be estimated, 120 lb. with its probable contents of moisture. He also found the unit weight of the clay core to be 100 pounds.

If the problem be considered entirely on the basis of Mr. Hazen's finding of weights, and of his conception of mixing and distribution of materials, it is evident that sliding must have taken place along some plane of deeply penetrating pure clay layer, and that one such layer must have existed near the approximate elevation of stable base. The question remains how far out from the remaining liquid core this layer of clay may have extended.

In view of the declared effort to have the core extend to the indicated slope lines of 2 to 1 and 1¼ to 1, it is here assumed that, in spite of the subsequent sinking of outer fill, some pure clay did extend at least to the slope lines 1.6 and 1.25 to 1. If this assumption, which is admitted to be arbitrary, is approximately correct, the upstream 234-ft. width of base developed material friction opposing sliding, while the remaining 209.5 ft. may have been practically frictionless.

The weight borne by the upstream portion cannot differ materially from the weight of the mass vertically above it, which figures 548 tons, as compared with 1920 tons figured by Mr. Hazen to be the weight of the entire prism, and 387 tons figured by him as the horizontal core pressure. Thus, the following values for sliding factor would result:

548 tons on dry-fill base, 387 tons horizontal pressure, 0.71 sliding factor
1372 tons on wet clay base, 0.00 sliding factor

1920 tons on entire base, 387 tons horizontal pressure, 0.20 av. sliding factor

Corresponding figures for the downstream portion of the dam are as follows:

791 tons on dry-fill base, 387 tons horizontal pressure, 0.49 sliding factor
969 tons on wet clay base, 0.00 sliding factor

1760 tons on entire base, 387 tons horizontal pressure, 0.22 av. sliding factor

On the above basis, the factors originally figured for the dry base, at 0.83 and 0.48, towards and away from the reservoir, respectively, should be amended by reason principally of different weights to 0.71 and 0.49, the former resulting in sliding, and representing the coefficient of friction of dry-fill base. The friction coefficient of the entire base was 0.20, as stated by Mr. Hazen.

It will be quite evident that different assumptions as to relative proportion of clay base will produce different results, and, as definite determination has been made impossible by the slide, no certainty as to these values can now be had.

Nevertheless, similar reasoning and approximation of forces in other dams with hydraulicked clay core may permit an intelligent comparison. The writer therefore suggests an amended rough conclusion, drawn on the basis of corrected assumptions, viz.: That a sliding factor of about one-half for the dry mixed rock and earth fill used in the dam was safe, and that when this factor reached 0.71 sliding took place.

Portland, Ore. D. C. HENNY.

How One German Military Tunnel Looks

Sir—The accompanying sketch shows a typical section of what is known as the "Crown Prince Tunnel," constructed on Mort Homme Hill by the Germans for the purpose of affording protected shelter against shell fire and for the conduct of troops to locations on the line. The tunnel was constructed in the side of the bill heading in at grade through a chalk-rock formation, with an average depth from the surface of the ground to the floor of the tunnel of about 35 ft. It could house comfortably 2500 men.

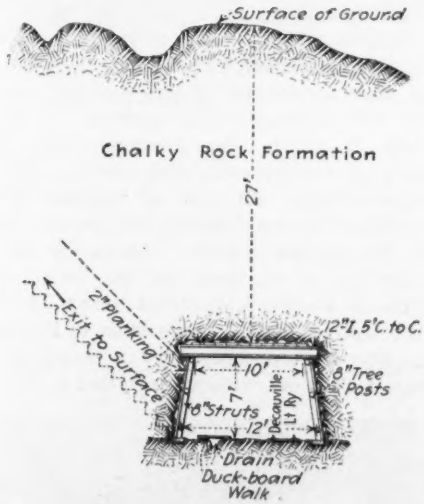
It is situated on the western slope of Mort Homme, about nine miles northwest of Verdun, and runs in a general northeast-southwest direction for a total length of about 750 m. On this hill and the adjoining hills—

No. 304, Montfaucon, Bois de Carbeaux—the greatest fighting of the war was done, and I think it no exaggeration to say that not one square foot of Mort Homme has remained unaffected by shell fire, the hill presenting to the eye one mass of contiguous shell holes and churned earth.

Mort Homme has two German-built tunnels, the Bismarck and the Crown Prince, the Bismarck being the smaller. It is said that the crown prince occasionally visited the tunnel bearing his name and, in fact, had a room therein.

The exits from the tunnel are mostly on the southerly side, marked A in the sketch, a few being on the north side, and there are openings at either end. There are about 10 exits or entrances in all, the entrance to the tunnel being accomplished by means of the northeast end.

There are a number of rooms built into the tunnel, about 10 in all. These rooms are built in the rock without impinging on the tunnel area, which is unobstructed throughout, and they average about 15 ft. square. The rooms comprise three sleeping rooms with bunks, for about 20 men, one kitchen, and a suite of rooms used as an infirmary with about eight cots in it. The infirmary is located at the northeast end, and a number of wounded and the medical staff were killed when a French shell sealed this opening. It may be well to state here that the Decauville railway cars were fitted up with a stretcher arrangement, which was



TYPICAL SECTION OF CROWN PRINCE TUNNEL, BUILT BY GERMANS ON MORT HOMME HILL NEAR VERDUN.

probably used for conveying the wounded to the infirmary from the various openings. The rooms on the northerly side were the dynamo room, with a completely equipped electric-lighting plant, which was housed in a room 12 x 24 ft. long, and another room which contained a ventilating plant of the blower type.

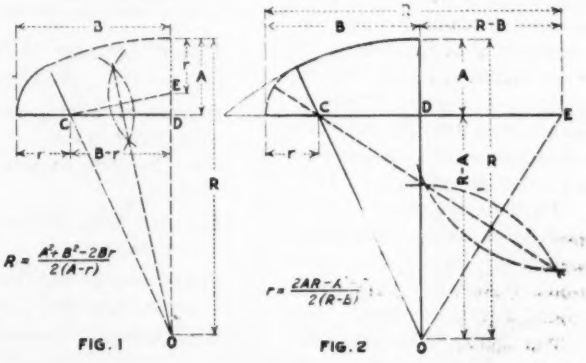
The tunnel is undamaged excepting at the northeast, which was destroyed by shell fire and sealed for about 30 m. At two other points near the southwest end shell fire had caused the rupture of the roof boarding, but the beams were hastily reinforced by 10-in. posts, placed vertically under the center of the beams.

When this hill was finally captured by the French, 1200 prisoners were taken from this tunnel.

DANIEL I. CURTIN,
Captain of Engineers, United States Army.
Thirteenth Engineers, Verdun, France.

Construction of Three-Centered Ellipse

Sir—The accompanying diagrams and equations illustrate a simple graphical and algebraic solution for the construction of a three-centered false ellipse. Fig. 1 indicates the solution when the short radius r is known or assumed, and Fig. 2 the solution when the longer



radius R is known or assumed. In both cases the algebraic solution follows directly from the simple relations existing between the sides of the right triangle OCD.

The graphical construction in Fig. 1 is as follows: Lay off r on the vertical axis, locating E as shown. Connect E with center C, and erect a perpendicular bisector of CE; it will cut the vertical axis at O, the center for radius R.

Similarly, for Fig. 2: Lay off R on horizontal axis to locate E as shown, connect E with the center O, erect the perpendicular bisector of OE; it will cut the horizontal axis at C, the center for radius r.

There are other solutions, but these seem most satisfactory.

BERNHARD SILBERBERG,
Assistant Engineer, Board of Public Works.
San Francisco, Cal.

Asphalt Street Maintenance in Los Angeles

Three methods are used in repairing asphaltic street surfaces in Los Angeles, according to the annual report of the Engineering Department for the years 1917 and 1918. The methods are patch work, cover work and the surface-heating process of resurfacing. Patch work is done by the old method of cutting out and refilling. The cover work consists of cutting a binding edge around the surface to be repaired, and covering the existing asphalt surface with a thin layer of hot asphalt. The surface-heating process of resurfacing consists in heating and removing any desired thickness of the old asphalt surface, and replacing it with new. During the fiscal year covered by the report, the amount of work and the unit cost thereof was as follows: Patch work, 141,181 sq.ft. at 4.73c. per square foot; cover work, 1,012 092 sq.ft. at 3.07c. per square foot; heater work, 1,170,420 sq.ft. at 5.92c. per square foot.

HINTS FOR THE CONTRACTOR

DETAILS WHICH SAVE TIME AND LABOR ON CONSTRUCTION WORK

Portable Pumping Outfits Unwater Trenches for Lowering Pipe Lines

PORTABLE pumping outfits are giving excellent service in various unwatering operations in connection with the Miami Valley flood-protection works. They have been employed particularly in the work of lowering pipe lines, which has been made necessary by the deepening of the channel of the Miami River at Dayton, Ohio. Two sizes of outfits have been used for the pipe-line jobs. The smaller outfit consists of a 6-in. belt-driven volute pump operated by a 30-hp. cage-type electric motor, costing $82.50 for the pump and $416 for the motor. The larger size has an 8-in. pump and a 50-hp. motor costing, respectively, $136 and $562. In both outfits the pump and the motor are mounted on the same bed timbers, with a small weatherproof house built over the motor and a narrow roof extending over the belt to protect it from material that might drop from the buckets of excavating machinery. Four hooks in the bed timbers, to which may be attached short pieces of cable, enable the outfit to be readily lifted by crane or derrick for loading and transporting. On land the outfits were moved by motor truck and on water they have been moved on an 8 x 18-ft. general-utility deck scow.

When first sent out, the pumps were equipped with a foot valve only. On the job they were supplied with a gate valve on the discharge pipe. This valve serves two purposes: When entirely closed it retains the water for priming the pump, and when partially closed it can be made to regulate the discharge so as just to take care of the inflow into the excavation. With the pump steadily running, the gate valve can be manipulated so as to keep the water level in the excavation at any desired elevation to meet the requirements of the work.

Priming the foot valves gave rise to much difficulty. Pebbles or other obstructions would collect on the valve seat, despite the use of a strainer, and at times allow the water to flow out almost as fast as it could be poured into the pump. With a gate valve installed on the discharge pipe a more satisfactory method of priming is to pump out the air with a pitcher or diaphragm pump. The general method of procedure on the Dayton work was to excavate with the dragline machines to as near the crossing pipe as possible without damaging it with the bucket, and to build a cofferdam or low levee around the work with the excavated material. The excavating had to be carefully done on account of the weight (about four tons) and unwieldiness of the buckets. It was found that about 2 ft. is the minimum safe distance from the pipe for excavating by machine, when the work is unwatered. As soon as sufficient cofferdam had been placed the pumping outfit was swung into position by the dragline machine, a sump dug out for the suction, and the pit pumped out. As the pit was unwatered the excavation was carried down with the dragline to the desired depth on both sides of the pipe line. The pipe was then uncovered by a shovel gang, the joints were melted out with an acetylene torch, and the

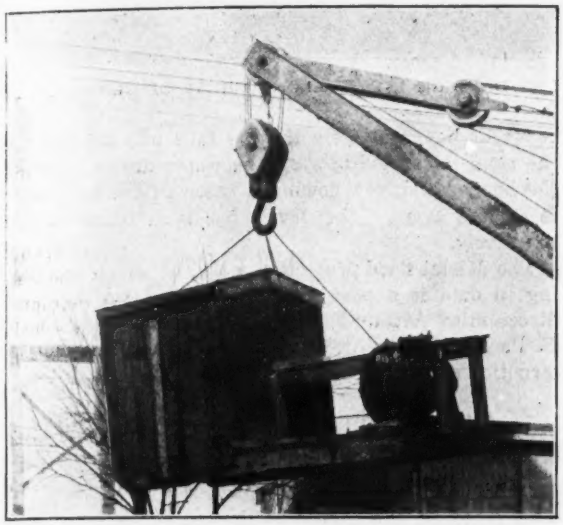
Other Articles in This Issue of Interest to Contractors:

Sources of Supply of Unskilled Labor for Highway Work — Page 466
Some Pointers on How to Finish a Concrete Floor — Page 477
Macadam Road Built by Red Cross Refugees in China — Page 478
State-Insured Highway Construction Contracts Suggested (Letters) — Page 484
The Cost-Plus Contract a Success (Letter) — Page 485

PORTABLE PUMPING OUTFIT UNWATERING EXCAVATION FOR PIPE LINE

sections of pipe were lifted aside by the dragline machine. A new trench was excavated with the machine, and the pipe was relaid in its new bed.

On one of the pipe-line jobs a pit 200 ft. long and about 30 ft. wide at water level was unwatered to a depth of 5½ ft. in 20 min. by the 8-in. pump. The pit was kept pumped out continuously by this pump to a depth of 6 ft. below the surrounding water surface. In another instance a pit 300 ft. long and about 50 ft. wide at the water line was excavated, exposing 250 ft. of pipe line. An extra wide pit was dug in this case to provide ample working space so that the pipe line could be lowered in place without unjointing it. The material



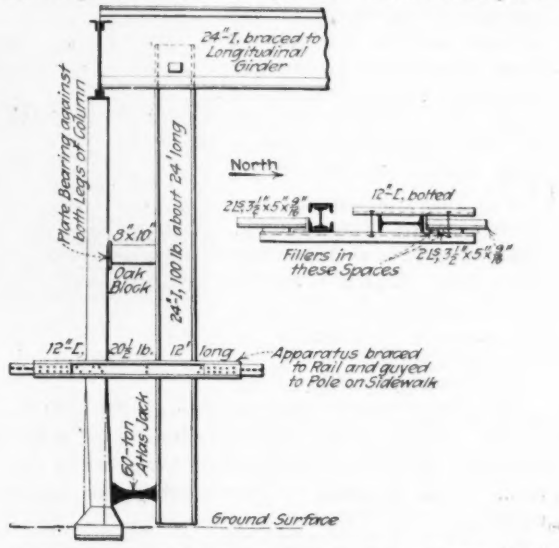
LOCOMOTIVE CRANE LOADS PORTABLE PUMPING OUTFIT ONTO MOTOR TRUCK

in this cofferdam contained considerable silt. One 8-in. pump easily kept the pit unwatered to a depth of 9 ft. below the surrounding water surface of the river.

Arthur E. Morgan is chief engineer, Charles H. Paul is assistant chief engineer and C. H. Locher is construction manager of the Miami Conservancy District.

Jack Straightens Bent Steel Column

TWO bent columns were successfully straightened in one afternoon with a device improvised from materials on the job. A railway traverses the street under the elevated line on Gravesend Ave., Brooklyn, N. Y. Shortly after the erection of the elevated structure, a girder on a passing material train broke loose from its fastenings, and, striking three columns, bent two of them and twisted the third. The twisted column had to be replaced. The more badly distorted of the two bent columns was, at the point where the girder struck it, bent out of plumb ¾ in. on the east face and ⅜ in. on the north face. Both columns were straightened in the same manner. A 24-in. I-beam was set up and fastened to the elevated structure above and braced to the ground below. Then it was tied to the column at the bent point, as shown by the drawing. A jack was set between the column and the I-beam near the ground, and higher up a timber block was inserted. The ratio of the distance between jack and tie and block was 3 to 2. Each ton pressure on the jack stressed the tie 2½ tons. Pressure was applied until the column returned to plumb and ½ in. beyond it. Both bends prac-


24"-I, braced to Longitudinal Girder
Plate Bearing against both Legs of Column
North
12"-I, bolted
2 L's 3½"x3½"x⅝"
8"x10" Oak Block
24"-I, 100 lb. about 24' long
Fillers in these Spaces
2 L's 3½"x3½"x⅝"
12"-I, 20½ lb. 12' long
Apparatus braced to Rail and guyed to Pole on Sidewalk
60-ton Atlas Jack
Ground Surface

SCREW-JACK ARRANGEMENT FOR STRAIGHTENING BENT COLUMNS

tically disappeared in the operation. The procedure was equally successful with the second column.

The work was performed by Post & McCord, Inc., New York City, contractors for the section of the elevated road on which the accident occurred. This description is taken from an article in the *Public Service Record* by William E. Rudolph, section engineer.

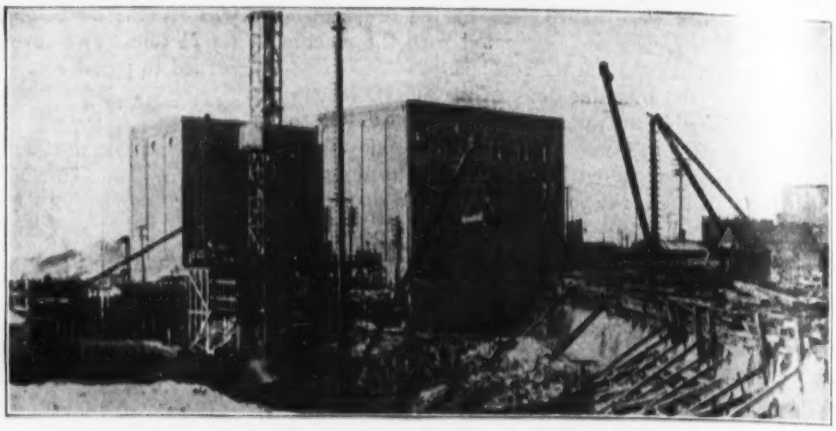
Two Derricks Operated by One Engine and Crew

IN MAKING plant arrangement for the replacing of a dam across the Mississippi River at Little Falls, Minn., the contractors, Siems, Helmers & Schaffner, of St. Paul, Minn., provided a traveling stiffleg derrick moving along the crest of the old dam, the proposed location of the new structure being such that it could be commanded in its entire length from this position. This derrick was equipped with a three-drum engine, fitted with an extra clutch winch for nigger-head work, regular swinging of the derrick being handled by a separate swinging engine.

After the beginning of cofferdam construction, it was decided by the owners to change the location of the new structure, moving it downstream to obtain better foundation conditions. This necessitated the installation of an additional derrick that would command the site, but also relieved the upper derrick of a considerable amount of the work which it was originally figured to do. The contractors therefore provided a guy derrick with an 80-ft. mast and a 70-ft. boom, set on a skid to facilitate its being moved from time to time to command the various portions of the operation.

The boom fall line was taken off the original stiffleg derrick and replaced with a fixed boom fall. With the aid of extra blocks, this left the stiffleg derrick in its original position with a fixed boom reach, one engine-

operated load line and the swinging arranged to be done by nigger-head lines. This permitted the continued use of this derrick for landing form sections, steel and other material from the contractor's yard above the dam. The remaining two engine lines were used respectively for boom fall and load line in the guy derrick, with the swinging engine rigged to do the swinging. The original location of the stiffleg derrick gave the operator an unobstructed view of both rigs.



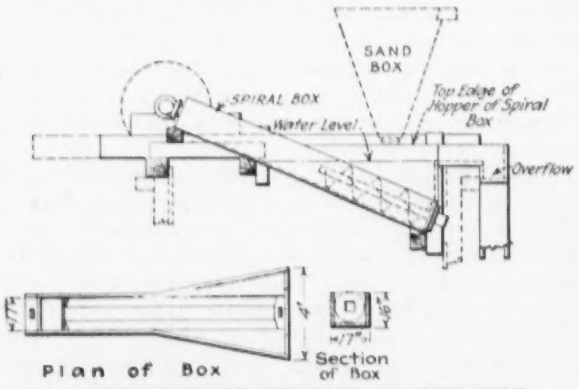
TRAVELING STIFFLEG DERRICK MOVES ALONG CREST OF OLD DAM

After the completion of the work in the river bottom, the guy derrick will be removed and the stiffleg derrick rereeved as originally installed and used for tearing off the crest of the old dam. R. D. Thomas, of Minneapolis, was consulting engineer.

Screw Conveyor Rids Washed Sand of Surplus Water

ATTACHMENT of a simple screw conveyor device to the gravel and sand-washing and screening plant at the Lockington dam of the Miami Valley flood-protection works has successfully eliminated the surplus water carried into the washed-sand bins. The washing and screening plant is of the standard construction employed on the protection works, as described in *Engineering News-Record* of Oct. 10, 1918, p. 680. The sand, wet from washing, flows down the sand screen into an inverted cone hopper which it nearly fills. Most of the contained water rises and overflows through a notch in the top edge of the cone. As the cone becomes full, a counterweighted bottom valve opens and lets the contents fall into the sand bin.

Trial showed that the sand going into the bin was too wet, and to remove this excess water the device illustrated was attached. Now the sand discharged from the cone falls into the screw conveyor hopper, whence it is carried by the screw conveyor up the inclined conveyor box, and from the top falls into the bin. As the sand is carried upward the water drains back into the hopper and, overflowing a notch in the hopper top, is carried away. The device has been found to work effectively.



EXCESS WATER DRAINS FROM WASHED SAND ASCENDING INCLINED CONVEYOR

The Miami flood-protection work, of which the Lockington dam is a part, is being carried out under the direction of Arthur E. Morgan, chief engineer, Charles H. Paul assistant chief engineer, and C. H. Locher, construction manager.

Guard Rope Against Freezing and Prevent Possible Accidents

MANILA or other fiber rope is made brittle by freezing, and should be thawed before being used. Accidents happen because of the neglect of this precaution.

Few contractors try to care properly for fiber rope; neglect of handy rope and of rope used for tackle is particularly flagrant. Fall rope and that used in standing rigging do not absorb much moisture, soon dry out in the wind, and are comparatively free from dirt. They need no special care to prevent freezing. With general utility rope the case is different. A manila rope contains only a small amount of natural moisture, but it will absorb as much as 30 to 40% in a damp atmosphere.

The moisture does no injury, but the freezing of the contained water makes the fibers brittle and the rope weak; therefore the frost should be thawed out before the rope is used subsequently for heavy lifts or pulls.

Dirt is objectionable chiefly because it reduces the working life of rope. When working, the rope fibers move and play on each other and the grit in the dirt cuts and frays them rapidly. On a construction job a visitor recently had to pick his way over the tangle of handy rope and tackle left lying where last used, and frost was in every inch of this rope.

When finished with a rope put it where it will not freeze or be ground into the mud; if this is impracticable coil down the rope and set this coil on a pile of boards or on any other handy object, so that it will have some chance to dry. C. S. H.

NEWS OF THE WEEK

New York, March 6, 1919

Reconstruction in France To Be Delayed for Year

A correspondent with good sources of information writes to *Engineering News-Record* as follows, with reference to reconstruction in France:

"Reconstruction will be a matter of at least a year hence. The work has not even been organized, and with the French habit of talking a thing to death before actually doing any work, the prospects for a speedy beginning are anything but bright."

Civil Engineers' Branches Studying Development Work

Both the Philadelphia and the Pittsburgh Associations of Members of the American Society of Civil Engineers have appointed committees paralleling the subcommittees of the Development Committee of the society. These committees have drafted reports which will be the basis of discussion regarding recommendations to be made by these local associations to the Development Committee. The Pittsburgh Association's committees reported last month, and the Philadelphia Association's committees reported Mar. 3. The number of topics being so large that they could not all be discussed at the last meeting, the Philadelphia Association will finish the discussion on Apr. 7, the committees' report meanwhile being put in type for the information of the members.

Congress Passed Few Bills That Interest Engineers

Only two bills of the many concerned with engineering matters were enacted in the deadlock that marked the final days of the 65th Congress. These are the rivers and harbors bill carrying an appropriation of $37,000,000 for construction and maintenance and also the provision for an investigation of the St. Lawrence River navigation route, noted on this page, and the bill appropriating $10,000,000 for the purchase of the Cape Cod Canal. Among the many bills and parts of bills that died were the water-power and the coal and oil lands leasing bills, the appropriation of $750,000,000 for the railroads, Secretary Lane's proposed appropriation of $100,000,000 for the reclamation of land for the use of soldiers, Senator Kenyon's emergency public-works commission, the Caldwell amendment providing that excess Government machine tools be turned over to the colleges, and the entire Army, Navy, sundry civil, public buildings and general deficiency appropriation bills. The bill validating the informal war contracts was passed and the machinery for its operation is now being put into motion. The daylight-saving law remains in force, as the amendment to the agricultural appropriation bill repealing the law failed with the bill.

Employment

For the convenience of engineers returning from military life, and others, there are listed below agencies which may be helpful to those who are seeking employment:

Professional and Special Section, United States Employment Service; Thomas T. Read, manager Eastern zone, 16 East 42nd St., New York, and Ward R. Robinson, manager, Central and Western Zone, 63 E. Adams St., Chicago.

Engineering Societies Employment Bureau; Walter V. Brown, secretary, 29 West 39th St., New York City.

American Association of Engineers, F. H. Myers, manager, 29 So. La Salle St., Chicago. Service to members only, but Army or Navy engineers in uniform who are eligible to certified membership may join without payment of entrance fees or dues while in uniform and for six months after discharge.

Appoint Reconstruction Advisory Committee

In response to a request from Chairman Abram I. Elkus, of the Reconstruction Commission of the State of New York (office in the Hall of Records, New York City), the Engineering Council has appointed an Advisory Committee of five well known engineers: George W. Fuller, chairman; H. de B. Parsons, George F. Kunz, Paul G. Brown and L. B. Stillwell, who represent the several branches of the profession and the member societies of the Engineering Council. This committee is to confer with the commission upon public works and other engineering matters, particularly the following: (1) The proposed vehicular tunnel under the Hudson River between Manhattan Island and Jersey City; (2) water-power development; (3) sewerage and sewage disposal; (4) garbage disposal and utilization, and (5) port development.

Governors and Mayors Discuss Reconstruction Three Days

At the invitation of the President 19 Governors, the representatives of many other state heads, and 137 mayors, met this week at the White House to discuss "the proper method of restoring all labor conditions to a normal basis as soon as possible and to effect any such alterations of labor and endeavor as the circumstances may make necessary," to quote the President.

The first two days were given over to addresses by the President and his cabinet officers and reports by Governors and mayors as to conditions in their respective states and cities. The last day, the deliberations of which were too late to be noted in this issue, was devoted mainly to a consideration of the resolutions which represent the action of the conference. The Governors, for the most part, reported hopeful conditions as to labor and industry, but the mayors generally told a different story. Constructive measures were absent in the first two days, though toward the end there was a notable trend toward recommendations looking to the investigation of prices, and insistence on railroad purchasing of material.

Bill Authorizes Investigation of St. Lawrence Navigation Route

A final paragraph to the Rivers and Harbors Bill which has been signed by the President authorizes the International Joint Commission, which regulates boundary waters between the United States and Canada, to investigate what further improvement of the St. Lawrence River between Montreal and Lake Ontario is necessary to make the river navigable for oceangoing vessels. The commission is ordered further to report to the Government of the Dominion of Canda and to the Congress of the United States its recommendations for coöperation by the United States with Canada in the improvement.

Seven Bids for Devil's Lake Dam

Bids for the Devil's Lake Dam, an element in the flood-control project of Los Angeles County, California, outlined in *Engineering News-Record* of Feb. 13, 1919, p. 351, ranged from $169,908 to $239,315. Bent Bros., Los Angeles, were the lowest of the seven bidders. The contract had not been awarded at latest reports, owing to the high prices asked for cement, which was to be supplied by the county. J. W. Reagan, Los Angeles, is chief engineer for the work.

Interest at Meeting of American Road Builders Centered in Post-War Problems

Topics Included National Highways, Motor Truck Regulation, Use of Materials for Heavy Traffic, Reconstructing Roads and Bridges

New conditions due to the war, and greatly increased motor-truck traffic, received consideration in many of the papers and committee reports of the American Road Builders' Association, held last week at the Hotel McAlpin, New York City. The attendance was estimated at 1350. A national highway commission and system, regulation of the various dimensions, speed and weight of motor trucks, proper materials and their proper use for heavy traffic, and the reconstruction of pavements and bridges to carry this traffic, were dealt with in various papers, discussions and reports.

Joint Sessions of the Convention

While the convention was primarily one of the American Road Builders' Association, one day was given over to a joint meeting with the American Automobile Association, the Highway Industries Association, the National Highways Association and the National Highway Traffic Association. Practically all the papers at these two sessions dealt with national aspects of good roads and the steps that must be taken to obtain a unified national system. Most of the proceedings consisted of committee reports on the above subjects, there being only two papers read, one by George H. Pride, formerly member of the Highways Transport Committee, on the "Inter-relationship of Highways, Railways and Waterways," and an address on "National Highways," by T. Coleman du Pont of the National Highway Association. Mr. Pride predicted that hauls up to 100 miles by motor truck would be found to be profitable and would not interfere in any way with railroad or waterway transportation.

The report of the Committee on National Highways was read by E. J. Mehren, editor of *Engineering News-Record*. Mr. Mehren spoke at length in advocacy of a Federal highway commission to build, maintain and control a Federal highway system. The Federal-aid law, under which the Bureau of Public Roads now operates, was designed to promote state highway systems. The Federal money is contributed to the states and the roads are built by state road officials. There was doubt in Mr. Mehren's mind whether these officials could use this money to build a system adequate for the Federal Government, when such system would not be to the best interests of their respective states, without violating their oaths of office. State officials must build the roads in locations to serve state interests best, rather than with an eye to direct national routes.

Reports on the reconstruction and strengthening of highway bridges and roadways of trunk highways to accommodate motor-truck traffic were presented for the committees of which they were chairmen by Willis Whited, bridge engineer, Pennsylvania State Highway Department, and H. E. Breed, first deputy commissioner of highways, New York. Mr. Whited stated that the committee deemed it necessary to make inspections of all highway bridges and determine at once what should be done to strengthen or reconstruct them. All new bridges should be designed for a maximum load of 20 tons. The report made by Mr. Breed recommended that in reconstructing narrow roads for trunk highways the minimum width should be 20 ft., with an allowance of 9 ft. for each additional lane of traffic.

George H. Pride read the report of the committee on regulations covering speed, weight and dimensions of motor trucks. The committee recommended the following: Maximum weight on four wheels, 28,000 lb.; maximum speed, 15 miles per hour; maximum weight per inch width of tire, 800 lb.; maximum width of truck, 96 in.; gross length of truck, 28 ft.; maximum height, 12 ft. 2 in. Resolutions recommending the features advocated by Mr. Mehren and Mr. Pride were passed at the last session of the convention.

Road Builders' Association

Besides the abstracts on p. 464 other papers and reports may be noted.

"Recent Developments in the Construction, Maintenance and Reconstruction of Cement Concrete Pavements," was the subject of an address by A. D. Williams, former chairman of the State Road Commission of West Virginia. Among the practices which have become established recently, as outlined by Mr. Williams, are: The submerged or invisible joint to take care of expansion, and the resurfacing of old concrete roads with from 2 to 3½ in. of new concrete. The latter practice has been successful on the Western Pike in West Virginia.

Cost keeping is often carried to such a fine point by highway contractors that it loses its usefulness, according to H. P. Gillette, editor-in-chief of *Engineering and Contracting*. To be of value, costs should be found daily and weekly for each item having a contract price.

One of the liveliest discussions of the convention was precipitated by the report of the committee on the economic status of guarantees for pavements on roads and streets, read by F. P. Smith, consulting paving engineer, New York City. The committee recommended that guarantees be required for the life expectancy of the pavement without repairs. The whole theory of guarantees was opposed by many of the contractors and engineers present. It was contended that guarantees always greatly raise the cost to the city and generally involve a law suit.

Among the resolutions adopted that have not already been mentioned were: One addressed to the Secretary of War, requesting the return of all road-building regiments from overseas at the earliest possible moment; one asking for the readjustment of freight rates to favor road materials, and several advocating earliest possible resumption of all road building.

Iowa Engineers Work for Technical Publicity

State-wide organized engineering publicity, directed by a central committee, has been initiated by the Iowa Engineering Society. Activities of the publicity committee, headed by R. W. Crum, and discussed at the annual meeting Feb. 19-20 in Muscatine, include a plan of action already in operation that has transformed the society from an organization active two days a year to one in continuous operation. License legislation—indorsed by all engineering organizations of the state—society organization, hard-road possibilities and drainage problems, were other topics presented.

The publicity scheme consists mainly in energizing a local engineer in each community to the point of coming into close contact with the local editor, to prepare local material and have printed the material of state-wide interest furnished by the central committee.

"Push public work now" was an idea for which the committee asked every engineer to act as publicity agent. Resolutions to that effect were passed, put into the Muscatine paper in full, and sent by the latter's syndicate service, over the state. Further admonitions were given to talk the slogan to members of councils, boards of supervisors, chambers of commerce and influential citizens. Charles H. Young expanded the idea in his presidential address, exhorting the engineers to promote "carry-on" conventions in each community before going to a proposed state convention at Des Moines.

During the meeting a group of members of the American Society of Civil Engineers authorized a committee to take steps toward the formation of an Iowa Association of Members of the American Society of Civil Engineers. Two new sections of the state society were authorized, mechanical and electrical. A special committee on professional practice was charged with running down rumors of unprofessional conduct, bringing the alleged offenders to justice or stopping the stories; also to handle the problem of engineers' compensation. A minimum wage scale was recommended of $200 for engineers in charge, $175 for instrument men and $150 for draftsmen.

The officers elected for the year are as follows: C. H. Currie, president; H H. Dean, vice-president; C. H. Streeter and A. F. Fischer, directors; J. H. Dunlap, Iowa City, secretary-treasurer.

Wisconsin Engineers Meet

Encourage construction, prepare plans and let contracts early, and preach optimism—these were the duties with which Wisconsin engineers were charged by the speakers at the annual meeting of the Engineering Society of Wisconsin, held Feb. 21-22 at Madison. A committee on licensing was created.

War, said T. Chalkley Hatton in his presidential address, had taken hundreds of young engineers and put them in positions of responsibility which they would not have reached in many years of civil practice. The country, therefore, has a large body of engineers, men trained to new ideas of coöperation, coördination and speed of production. The only way by which the engineer can meet the higher wage and price scales is by better planning, by improving and coördinating construction methods.

A. R. Hirst, engineer of the State Highway Commission, said there are not in Wisconsin, nor in neighboring states, enough engineers, contractors and inspectors trained in road construction to build the mileage of road for which money was available and which highway officials stood ready to place under construction. This calls for the best of planning and the highest development of mechanical aids to increase output and speed.

Last Meeting of the Season Held

The third and last, and perhaps the best, meeting of the winter season of the New York Section of the American Water-Works Association was held in New York City Feb. 19. Charles R. Bettes of Far Rockaway was elected a member of the board of governors.

The development of the water-treatment motor trucks used by the American Expeditionary Forces in France was outlined, and the trucks were described, by William J. Orchard, manager of the Wallace & Tiernan Co., New York City. These trucks (*Engineering News-Record*, Sept. 5, 1918, p. 458) included a combination of mechanical filter, a chlorinating apparatus and pump and storage tanks; also pumping and chlorinating apparatus alone. Some 50 units had been delivered in France, and others had been contracted for, when the armistice was signed. In order to make it possible to operate the laboratory on the truck it was found necessary to mount the pump on springs.

Application of the chloramine process of water treatment to Esopus Creek, before it enters the Ashokan reservoir, was detailed by Dr. Frank E. Hale, director of the Mount Prospect Laboratory, New York City. Studies of compound meters prior to their possible adoption by New York City were outlined by Fred B. Nelson, assistant engineer of the Department of Water Supply.

Cuyahoga River Conservancy Commission Proposed

The county commissioners of Cuyahoga County are considering the formation of a conservancy district under the Ohio conservancy law, for the purpose of straightening the Cuyahoga River, as a preliminary to the construction of a large bridge across that stream.

Waterways and Drainage Commission Proposed for Missouri

A bill abolishing the present State Land Reclamation Department of Missouri and creating a State Waterways Drainage Commission, to consist of a lawyer, a business man and an engineer, has been introduced in the Missouri legislature. The proposed commission would have charge of all drainage districts and reclamation projects.

First National Society to Adopt Cleveland Plan

A plan for joint membership in the American Society of Mechanical Engineers and the Cleveland Engineering Society, following the general scheme adopted by the latter some months ago, is announced in *Mechanical Engineering*, formerly the *Journal* of the Am. Soc. M. E. for February, as having been adopted in principle by both societies. The tentative plan provides for a division of dues between the two societies, with a reduction of $5 in the total yearly dues previously paid. Members of the national society may join the local society without paying an entrance fee. Members of the Cleveland society, on qualification and election to the Mechanical Engineers, would pay the difference between the entrance fees of the two societies. For members new to both societies the joint entrance fee would be $25—$18 to the national and $7 to the local society.

To Sell Aircraft Materials

Completion of plans and organization to sell surplus materials, including a considerable amount of lumber and shop equipment, has been announced through the Bureau of Aircraft Production, Washington, D. C., which has charge of their disposal.

Civil Service Examinations

United States.—Superintendents of road construction, Bureau of Public Roads, Department of Agriculture, Mar. 25: Class A (candidates with four years' responsible charge of construction) $150 to $175 per month; Class B (six years' responsible charge) $185 to $225; Class C (eight years' responsible charge) $230 to $250 a month. Apply to United States Civil Service Commission, Washington, D. C., or to local office of commission for form 1312, and file before Mar. 25.

United States.—Assistant examiner, Patent Office, Washington, Mar. 26-28, and May 21-23 and July 23-25. Pay, $1500 per year. Apply to United States Civil Service Commission, Washington, D. C., or to any local office of commission for form 1312, to be filed in time to arrange for examination at place selected by applicant.

United States.—Chief physicist, qualified in aëronautics, National Advisory Committee for Aëronautics, Langley Field, Hampton, Va., Mar. 25, $3000 per year. Also physicist, $2100 per year. Apply to United States Civil Service Commission, Washington, D. C., or to any local office of commission for form 1312, to be filed before Mar. 25.

United States.—Senior highway bridge engineers, Apr. 1, Bureau of Public Roads, Department of Agriculture, Washington, D. C. Grade 1 (examination percentage above 70) $2400 to $2700 per year; Grade 2 (percentage above 80) $2800 to $3000 per year; Grade 3 (percentage above 90) $3100 to $3400 per year. Apply to United States Civil Service Commission, Washington, D. C., or to any local office of the commission for form 1312, to be filed before Apr. 1.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

AMERICAN RAILWAY ENGINEERING ASSOCIATION; 910 Michigan Ave., Chicago; Mar. 18-20; Chicago.

NATIONAL FIRE PROTECTION ASSOCIATION; 87 Milk St., Boston, Mass.; May 6-8, Ottawa, Can.

AMERICAN ASSOCIATION OF ENGINEERS, 29 S. LaSalle St., Chicago; May 13-14, Chicago.

The Montreal Branch of the Engineering Institute of Canada will be addressed by C. V. Holslag, on "Electrical Welding," and by Hanbury A. Budden on "Patents and Engineering," at the meeting Mar. 13. A special meeting was held Mar. 4 at which H. H. Vaughan repeated his presidential address delivered at Ottawa, in which he reviewed the munitions industry in Canada.

The San Francisco Association of Members of the American Society of Civil Engineers held its regular bimonthly meeting Feb. 18. In the annual address of the incoming president, E. J. Schneider, he presented a "budget of suggestions" looking toward an increased membership, closer acquaintanceship among the members, and more

association activities during the coming year. To carry out these ideas, committees were appointed on membership, entertainment and public relations. The topic of the evening was "Concrete Ships," and brief talks were presented on various phases of the subject, by three speakers. Leslie W. Comyn, as president of the corporation which financed the building of the "Faith," told of the obstacles that had to be overcome in starting in the industry. Victor H. Poss, who designed the hull of the "Faith," described, with the use of slides, the details of design and construction. H. J. Brunnier, principal assistant engineer, Concrete Ship Division, Emergency Fleet Corporation, showed a large number of slides, illustrating the various types of concrete ships designed and built, and construction methods in several yards.

The New England Water-Works Association will hold its monthly meeting Mar. 12 at the Hotel Brunswick, Boston. William E. Foss, chief engineer of the Metropolitan Water Works, Clinton, Mass., will read a paper entitled, "A Brief Description of a Break in a 1200-Horsepower Turbine." M. N. Baker, associate editor of *Engineering News-Record*, will speak on "Meeting Water-Main Costs by Assessments for Benefits," followed by a discussion by Caleb M. Saville, chief engineer of the Board of Water Commissioners, Hartford, Conn.

The Engineers' Club of Philadelphia will hold an excursion Mar. 22 to the Philadelphia Quartermaster Terminal, at the invitation of Lieut. Col. E. B. Morden, Quartermaster Corps, U. S. A. C. W. Brown, of the H. K. Mulford Co., will speak on "Health Conservation," at the weekly luncheon Mar. 11.

The Utah Society of Engineers held a meeting Feb. 19 which was devoted to a discussion of the production of potash in the United States. W. D. Bonner spoke on the project of producing potash from the Nebraska potash "brine." O. C. Hart described the recovery of potash at the Brigham City cement plant.

The American Association of Engineers' railroad conference program, Mar. 17, includes addresses as follows: By H. P. Gillette on "Shall Engineers Be Paid Overtime?"; by J. L. Jacobs on "Principles and Procedure in Classification and Salaries of Railroad Engineers," and by W. W. K. Sparrow on "How Shall Proper Recognition Be Obtained?" A discussion on schedules of pay will follow the preliminary report on the subject. A member of the United States Railroad Administration has been asked to speak on the application of Order 27 and Supplements 7 and 8 to the railroad engineer. All professional engineers in railroad service, whether members of any society or not, are asked to participate.

The Northwest Master Builders' Association held its second annual convention in Seattle Feb. 20-21. Resolutions were adopted providing for a campaign for the establishment of trade schools throughout the Northwest. The following officers were elected for the year: President, J. B. Warrack, Seattle; vice-president, S. G. Morin, Spokane, and secretary-treasurer, S. C. Ericksen, Tacoma.

The Seattle Engineers' Club was addressed Feb. 20 by W. J. Santmyer, Puget Sound Traction, Light & Power Co., on "Powdered Coal As a Fuel."

PERSONAL NOTES

LIEUT. COL. WILLIAM C. HOAD, Sanitary Corps, U. S. A., who has been stationed in the office of the Surgeon General as advisory engineer on water-supply, sewage disposal, and general camp sanitation, has received his discharge from the service and has returned to the professorship of sanitary engineering, University of Michigan.

J. E. PENNYBACKER, chief of management, Federal Bureau of Public Roads, has resigned to become director of roads, American Automobile Association.

MAJ. W. D. A. ANDERSON, Corps of Engineers, U. S. A., has been appointed United States Engineer at Montgomery, Ala. Major Anderson was previously in command of the 218th Engineers at Camp Travis, with the rank of colonel, for the emergency. He was assistant to the chief engineer of the Army in Cuba in 1907 and 1908, after which he served as an instructor at the United States Military Academy.

GEORGE A. ELLIOTT, engineer, Spring Valley Water Co., San Francisco, has been appointed chief engineer of the company. Mr. Elliott has been in the service of the Spring Valley company for several years, and since the retirement of Hermann Schussler has been in charge of all construction work.

DR. F. W. MCNAIR, president of the Michigan College of Mines, has been appointed consulting engineer of the Bureau of Standards, Department of Commerce, Washington, D. C.

WILLIAM S. WILSON, supervisor of the Pittsburgh division of the Pennsylvania R.R., has been appointed division engineer, with headquarters at Oil City, Penn. He was born in 1880 and received his early education at the Central Manual Training School of Philadelphia. He entered railroad service in the construction department of the Pennsylvania Lines, and a year later was transferred to the office of the engineer maintenance of way, at Philadelphia. Two years later he was appointed assistant supervisor of the Trenton division.

HERBERT THOMAS ROUTLY, who was engaged in the carrying out of highway contracts for the New York State Highway Commission and contracts for county highway work in the vicinity of Dundas, Ont., has been appointed construction engineer of provincial highways of Ontario. He was born in Ontario in 1878, and is a graduate of the Collegiate Institute at Lindsay, Ont.

CAPT. ROBERT O. WHITEAKER, U. S. A., who recently returned from service with the field artillery in France, has received his discharge and will resume private practice in the firm of Whiteaker & Washington, civil engineers, Moore Bldg., San Antonio, Tex.

ROBERT M. KNOX, 70th Engineers, U. S. A., has received his discharge from the service and returned to his former work as general superintendent, A. Guthrie & Co., Inc., contractors and engineers, Blue Island, Ill., on their canal work for the Chicago Sanitary District.

WILLIAM C. PERKINS has resigned as chief engineer of the Dunn Wire-Cut Lug Brick Co. to become chief engineer and secretary of the Eastern Paving-Brick Manufacturers' Association.

CAPT. A. V. RUGGLES, 17th Engineers, U. S. A., has returned to this country and has received his discharge from the service. He has become engineer of construction and surveys in the Cleveland Water Department.

C. E. EDWARDS has resigned as maintenance engineer of the Yakima-Sunnyside project, United States Reclamation Service, to become district manager of the Columbia irrigation district, with headquarters at Kennewick, Wash.

L. W. DUFFEE, acting chief engineer of the Gulf, Mobile & Northern R.R., at Laurel, Miss., has been appointed chief engineer, maintenance of way department, with offices at the same point.

J. R. MCDERMOTT, 832nd Aëro Squadron, was recently discharged from the service after his return to this country, and has become assistant highway engineer of Harrison County, Ohio. He was previously field engineer for the Portland Cement Association.

D. O'HARA and A. L. SHAW announce the establishment of the firm of O'Hara & Shaw, consulting engineers, with offices in the Phelan Bldg., San Francisco. Mr. O'Hara, who was formerly consulting engineer for Jacobs & Co., New York City, recently re-

ceived his discharge from the Canadian Army, which he joined at the outbreak of the war in 1914. He was engaged in the supervision of a considerable amount of construction and engineering work for the Canadian forces on the western front, particularly in the vicinity of Ypres.

T. W. WHITE, assistant engineer, office of the bridge engineer, Canadian Northern Ry., Winnipeg, Man., has been appointed district engineer, Western District, with headquarters at Edmonton, Alta.

EDWARD C. HAYER, JR., formerly of the 29th Engineers, on duty at Washington, D. C., has received his discharge from the service and has returned to the engineering department of the Chesapeake and Ohio Ry. as assistant office engineer at Richmond, Va.

FREDERICK C. FREEMAN, first assistant chief engineer, United Gas Improvement Co., Philadelphia, has been appointed engineer of the Providence Gas Co., Providence, R. I.

ROLLIN J. WINDROW has resigned as city engineer of Waco, Tex., to engage in general contracting in that city. At the time of his appointment as city engineer he was a member of the State Board of Water Engineers, and was the first county engineer of McLennan County.

WILLIAM L. ROCKWELL, senior irrigation engineer, Bureau of Public Roads, Department of Agriculture, has been sent to Haiti to advise in irrigation development work, in accordance with a recent request of the Haitian Government.

W. H. FAIRCHILD, city engineer of Galt, Ont., has become manager of the Galt Public Utilities Commission, and will have charge of both the hydroelectric and water-works departments.

A. V. REDMOND, division engineer, Transcontinental division, Canadian Government Rys., has been appointed district engineer, central district, with office at Winnipeg, Man.

LIEUT. THORALF E. OLSON, 5th Engineers, Camp A. A. Humphreys, Virginia, previously of Trenton, N. J., having been discharged from the service, has resumed his work in the New Jersey State Highway Department as resident engineer for the state highway, with headquarters at Asbury Park.

E. N. FLOYD, who has been appointed supervisor of fire protection of the newly organized Bureau of Fire Prevention, Cleveland, Cincinnati, Chicago & St. Louis Ry. and associated lines, as mentioned in *Engineering News-Record* of Feb. 27, 1919, p. 450, was previously in charge of railway location work for the Miami Conservancy District, which he joined in 1914. Since that time he has been connected with various features of the work and was recently in charge of the railway location in the Huffman and Taylorsville basins.

H. L. VERCOE, special engineer, Canadian Northern Ry. at Winnipeg, Man., has been appointed district engineer, Prairie district, with headquarters at Saskatoon, Sask.

SAUL SHAW, maintenance engineer, Naval Aircraft Factory, Philadelphia, has resigned to become structural designer, Atlantic Refining Co., at Philadelphia.

CAPT. FRANK W. HARRIS, Engineers, U. S. A., has returned to this country and, having received his discharge from the service, is now located at Renton, Wash.

THOMAS TURNBULL, assistant chief engineer, Canadian Northern Ry., has been appointed engineer maintenance of way, western lines, with headquarters at Winnipeg, Man.

OBITUARY

MAJ. JOHN C. OSTRUP, a member of General Pershing's staff, died in New York City Feb. 28. Early in 1917 he sailed for France with the first detachment of the American Expeditionary Forces, as a member of General Pershing's staff, to which he had been assigned to advise in engineering work. He was the author of "Ostrup's Specifications." He was born in Denmark in 1864 and was graduated from the Danish Military Academy in 1885, later going into harbor work for the Danish Government. He came to this country in 1891, and since that time had been engaged in railroad and bridge work. In 1898 he was appointed engineer of maintenance, South Side Elevated R.R., Chicago, later entering the service of the Boston Elevated. He was afterward called to become professor of structural engineering at Stevens Institute of Technology, and maintained offices as a consulting engineer in New York City.

MAJ. JAMES N. HAZLEHURST, Corps of Engineers, U. S. A., previously of Chattanooga, Tenn., died in France Feb. 9, as reported in current casualty lists. He was born in 1864 and received his early education at Kirkwood Military Academy, afterward entering the service of the Memphis & Charleston Ry. as a rodman. He remained in railroad work until 1884, when he resigned as superintendent of construction, New Orleans & Mississippi Valley Ry. to enter the School of Design at Cincinnati as a student. A year later he became general manager of the Lookout Iron Works, and was also associated with the Montgomery, Ala., water-works, becoming principal assistant engineer in 1887. He afterward entered private practice and was in charge of the design and construction of many water-supply systems in the South, including those for Clarksville, Tenn., Algiers, La., St. Augustine, Fla., and Hazlehurst, Miss. For a number of years he was in partnership with Charles L. B. Anderson under the firm name of Hazlehurst & Anderson, with headquarters at Atlanta, Ga., and Wilmington, N. C. The firm was dissolved in 1911, after which Mr. Hazlehurst continued in private practice in Atlanta and Chattanooga. He entered the Army and went to France in 1917 and was engaged in water-supply work for the American Expeditionary Forces.

ROBERT E. MILLIGAN, general manager, New York Continental Jewel Filtration Co., Nutley, N. J., died in Newark, N. J., Feb. 25. He was 52 years old and had been engaged in water-supply and filtration work for the past 30 years. From 1889 to 1896 he was chemical engineer for the Continental Filter Co. of New York City, and was engaged in assisting in the design and operation of water-filtration plants in various cities. Mr. Milligan was in charge of the Continental Filter Co.'s work in St. Louis, and also represented the company in experiments at Pittsburgh. He was afterward engaged in reconstructing and improving the operation of municipal filtration plants at Quincy, Cairo, Danville and Moline, Ill., and installed a new filtration process for Vicksburg, Miss. In 1900 he became associated with the New York Continental Jewel Filtration Co., first as chief engineer, and two years later becoming assistant general manager. In 1907 Mr. Milligan was appointed general manager. During his service with the New York Continental Jewel Filtration Co. he had been in charge of and assisted in the preparation of plans for, and construction and operation of municipal filtration work in various cities, including Atlanta, Ga., Montreal, Portsmouth, Ohio, Charleston, S. C., and Scranton, Penn.

CARL STRADLEY, chief engineer of the Oregon Short Line since 1911, died at Salt Lake City Feb. 11. He was 53 years old. He entered railroad service in 1886 on surveys for the Union Pacific, and for several years was engaged in location work. For a few years he went into mining work, but in 1901 was engaged on location for the Oregon Short Line, remaining continuously in the service up to his appointment as chief engineer eight years ago. Under Government control Mr. Stradley was appointed assistant chief engineer of the Union Pacific System, under Federal Manager E. E. Calvin.

Construction and Prices: 1913 and Now

In Spite of High Costs, Contracts Let Last Month Were Only Twenty-Five Per Cent. Behind February, 1913

Nobody is in a position to state definitely just how far present construction activities are behind those of the latter pre-war years. An approximation, however, is possible by comparing the activities of, say, February, 1919, with those of the corresponding month of a typical year prior to the war. The following is a quick, brief study of February, 1919, vs. February, 1913, as gleaned from the "Construction News" pages of this magazine:

The first figures to compare are the grand totals. In February, 1913, contracts let numbered 340 and aggregated $53,058,000 against the 1919 figures of 256 contracts valued at $34,845,000 (exclusive of two $50,000,000 contracts which it would be unfair to include). Of course, these figures are not absolute. The system whereby they are collected has been vastly improved since 1913. However, the figures used for both years are, so far as the writer is aware, the most reliable of the kind in existence. Let them therefore be regarded as reasonably accurate. Then in February, 1913, there were 84 more contracts let than in February, 1919, the difference in value being $18,213,000.

The money value of contracts is of secondary importance to the number of contracts let; that is, one thousand $20,000 contracts mean far greater prosperity to contractors, engineers and manufacturers than twenty $1,000,000 jobs. Therefore, it should be noted that although last month the money value of contracts let was 70% of that of February, 1913, the number of contracts let was only 25% behind.

The two tables show the jobs let in each class of construction and the money involved in the particular periods under consideration. Work in four of the classes may be regarded as being normal, in four as subnormal and in two—streets and roads and industrial works—as far above normal. As a matter of fact, the money difference between the two periods may be more than accounted for in the $34,000,000 worth of railway work let in February, 1913. Very little grading and track work is under way at the present time, nor has there been much in the past four years.

After glancing at Table I, the most pessimistic will concede that road work is not merely picking up but is actually moving toward a boom. Last month bids were requested on 127 new projects and 65 contracts were let, aggregating more than $4,000,000, whereas in February, 1913, the contracts awarded amounted to only $2,254,000. As for industrial work, it would be reasonable to suppose that this class of construction had already been overdone; yet, last month $13,591,000 worth was let against only $1,672,000 six years ago.

Everybody in the business of supplying or using construction materials knows that the country is far underbuilt, nor is this knowledge restricted to contractors, engineers and manufacturers of construction materials. The many who have sought dwellings and apartments have learned how stringent is the housing situation. In February,

TABLE II. SHOWING CONSTRUCTION ACTIVITIES IN FEBRUARY, 1919

Week Ending	Water-Works	Sewers	Bridges	Streets and Roads	Industrial Works	Excavating and Dredging	Buildings	Federal Government	Miscellaneous	Total for Week
Feb. 6, 1919										
Number of bids requested	8	4	3	26	5	7	20	34	10	117
Number of contracts awarded	2	3	3	6	10	1	14	8	4	51
Total value of contracts awarded	$58,000	$214,000	$72,000	$515,000	$5,493,000	$13,000	$1,654,000	$391,000	$166,000	$8,576,500
Feb. 13, 1919										
Number of bids requested	10	7	4	34	5	6	28	27	9	130
Number of contracts awarded	1	2	8	12	8	2	2	6	1	42
Total value of contracts awarded	$6,500	$224,000	$206,000	$1,060,000	$410,000	$109,000	$179,000	$345,000	$92,000	$2,631,500
Feb. 20, 1919										
Number of bids requested	6	4	11	33	8	9	28	27	12	138
Number of contracts awarded	2	1	3	25	21	3	11	7	5	78
Total value of contracts awarded	$287,000	$543,000	$425,000	$1,368,000	$1,311,000	$325,000	$3,534,000	$250,000	$1,398,000	$9,441,000
Feb. 27, 1919										
Number of bids requested	2	7	5	34	1	6	6	12	9	82
Number of contracts awarded	.....	.....	.....	22	16	8	12	12	15	85
Total value of contracts awarded	.....	.....	.....	$1,396,000	$6,377,000	$2,265,000	$2,118,000	$500,000	$541,000	$13,197,000
February, 1919										
Bids requested	26	22	23	127	19	28	82	100	40	467
Contracts awarded	5	6	14	65	55	14	39	33	25	256
Value of contracts awarded	$351,500	$981,000	$703,000	$4,339,000	$13,591,000	$2,712,000	$7,485,000	$1,486,000	$2,197,000	$34,485,500

TABLE II. SHOWING CONSTRUCTION ACTIVITIES IN FEBRUARY, 1913

Week Ending	Water-Works	Sewers	Bridges	Streets and Roads	Industrial Works	Excavating and Dredging	Buildings	Federal Government	Railways	Miscellaneous	Total for Week (All Classes)
Feb. 6, 1913											
Contracts awarded	7	5	5	13	9	3	11	9	2	4	68
Value	$170,000	$181,000	$205,000	$421,000	$305,000	$239,000	$1,632,000	$673,000	$1,800,000	$578,000	$6,204,000
Feb. 13, 1913											
Contracts awarded	10	7	5	8	10	5	14	1	8	3	71
Value	$252,000	$1,634,000	$457,000	$153,000	$654,000	$247,000	$5,515,000	$80,000	$6,350,000	$145,000	$15,487,000
Feb. 20, 1913											
Contracts awarded	9	15	7	21	10	1	28	3	3	5	102
Value	$403,000	$304,000	$130,000	$1,075,000	$242,000	$32,000	$3,409,000	$119,000	$2,090,000	$1,802,000	$9,606,000
Feb. 27, 1913											
Contracts awarded	7	11	2	25	7	10	23	9	5	6	105
Value	$234,000	$504,000	$305,000	$605,000	$471,000	$1,764,000	$3,477,000	$294,000	$14,000,000	$107,000	$21,761,000
February, 1913											
Contracts awarded	33	38	19	67	26	19	76	22	18	18	340
February, 1919											
Contracts awarded	5	6	14	65	55	14	39	33	.....	25	256
February, 1913											
Value of contracts	$1,059,000	$2,623,000	$1,097,000	$2,254,000	$1,672,000	$2,282,000	$14,033,000	$1,166,000	$24,240,000	$2,632,000	$53,058,000
February, 1919											
Value of contracts	351,500	981,000	703,000	4,339,000	13,591,000	2,712,000	7,485,000	1,486,000	.....	2,197,000	34,845,500

1913, contracts were let for 76 large non-industrial buildings, valued at $14,000,000. Last month only 39 such building projects were contracted for, worth $7,485,000. Last month, however, bids were requested on 82 new projects.

That building is on the increase is indicated by the following:

From Nov. 7 to 14, 1918, bids were requested on 3 new building projects; Dec. 5 to 12, on 1; Jan. 9 to 16, 1919, on 8; Feb. 6 to 13, on 28; Feb. 13 to 20, on 28. These figures are only promising. They are not satisfactory in themselves. Much more building is needed to relieve the stringent housing conditions in this country.

As for public work, there is much to be done. Sewer work is practically at a standstill. One manufacturer of sewer-pipe told the writer that were he not also a manufacturer of hollow tile he would have to borrow lunch money. This was in New York. Water-works construction is away behind, contracts let being only 5 against 33 in February, 1913. The case of bridges is more encouraging. Fourteen contracts valued at $700,000 were let last month against 19 aggregating $1,000,000 in February, 1913. The same is true of dredging work, except that the value of the 14 contracts let last month was $400,000 in excess of the value of the 19 awarded six years ago. Federal Government work still exceeds pre-war conditions.

PRICES CONSIDERED

No discussion such as this is at all complete without a consideration of prices. There is no denying that the high price schedule prevailing today is an important factor in the seriousness of the construction situation. In February, 1913, cement sold for 90c. per barrel in bulk at the mill, whereas today it is $1.90. Crushed stone at dock in New York City was 85c. to 95c. per cu.yd. for 1½ in.; 90c. to $1 for ¾ in., against the present minimum of $1.65 and $1.75 respectively. Sand was 50c. per cu.yd. It is now $1.25. Gravel was 85c. to 90c.; it is now $2 a cu.yd. Steel plates in Pittsburgh sold for $1.45 per hundred and in New York at $1.61 (future deliveries in both cases), against today's quotation of $3 in Pittsburgh, $4.27 in New York. Cast-iron pipe in New York was $24 to $25 per ton for 6-in., against $62.70 today. As for pig iron, the February, 1913, Pittsburgh prices were $18.15 for bessemer, $17.15 for basic, against present prices of $32.20 and $30. Building materials are high, but that has ceased to be the "burning question"—which is, Are they going to be lower this season? The indication is that they are not going to fall very much.

It is complacent to say that if capital holds off long enough prices will tumble. It should be borne in mind that a rapidly declining market never indicates prosperity. It is almost safe to prophesy that prices will come down, but it is extremely doubtful whether the decline will be of such importance as to warrant postponing construction work. A price collapse is quite unlikely. Furthermore, it is the last thing that anyone desires. What is fervently desired and of primary importance if prosperity is to persist is a gradual lowering of prices to more attractive levels and a quickening in the placing of contracts. There must be confidence among the several parties—the party who wants work done, the party who wants to do it and the party who wants to supply the necessary materials. When this is established there will be good business for all. A. W. W.

Auto Truck Trailer Manufacturers Effect Reorganization

On Feb. 20 there was effected in Cincinnati a reorganization of the Trailer Manufacturers' Association of America. The following firms were represented: Miami Trailer Co., Troy, Ohio; Warner Mfg. Co., Beloit, Wis.; King Trailer Co., Ann Arbor, Mich.; Martin Rocking Fifth Wheel Co., Springfield, Mass.; Freuhauf Trailer Co., Detroit, Mich.; The Ohio Trailer Co., Cleveland, Ohio; Detroit Trailer Co., Detroit, Mich.; Arcadia Trailer Corporation, Newark, N. Y.; Rogers Bros. Co., Albion, Penn.; Northway Trailer Car Co., East Rochester, N. Y.; Troy Wagon Works Co., Troy, Ohio; Trailmobile Co., Cincinnati, Ohio.

The following officers were elected: W. E. Ferris, of the Ohio Trailer Co., president; W. A. Murfey, of The King Trailer Co., first vice-president; R. C. Sykes, of The Troy Wagon Works Co., second vice-president; J. C. Endebrock, of The Trailmobile Co., secretary-treasurer. The four officers, with W. R. Bond, W. F. Jolley and C. H. Martin, who were elected, constitute the executive committee.

In regard to legislation, it was pointed out that the manufacturers have been following legislation instead of leading. The difficulty of undoing legislation when once enacted was strongly emphasized, and measures were discussed to enable the association to take the lead in constructive legislative work that will not only benefit them but be a benefit to the public as well. The best legal talent will be engaged, and a digest made of all state and municipal laws available, upon which the legal efforts will be based.

Engineering and Business Interests Unite for Export Trade

A merger of large engineering interests with equally large exporting companies in New York, which will be known as the Factory Products Export Corporation, with offices at No. 2 Rector St., has been announced. The exporting organization concerned is a consolidation of the Factory Products Export Corporation and the Manufacturers' Agents Co., Inc., which have been building up a general export and import business in the Latin-American countries and the Far East since 1914 and 1916, respectively. The engineering interests are represented by the J. G. White Engineering Corporation of New York, and the activities of the company will be engaged in a general exporting and importing of hardware, machinery, engineering supplies, and building materials. The corporation expects to be of service both to the American manufacturer and the foreign buyer.

The Factory Products Corporation has business relations already established in Argentina, Chile, Ecuador, Venezuela, Mexico, the British West Indies, China, India, French Indo-China, Siam, Burma, Ceylon, Egypt and the Hawaiian Islands. These relations will be developed more comprehensively before there is expansion into new quarters of the world.

Walker W. Vick, former receiver general of Santo Domingan customs, is president of the corporation. Its directors are Louis E. Stoddard, of Bonbright & Co., Inc., and the Marlin-Rockwell Co.; George H. Walbridge, of Bonbright & Co., Inc.; Arthur H. Lockett, of Bonbright & Co., Inc.; E. J. Kulas, of The Cuyahoga Stamping & Machine Co.; E. N. Chilson of the J. G. White Engineering Corporation; D. M. Barclay and Mr. Vick.

Bridge Builders Report 12 Per Cent. of Capacity Taken

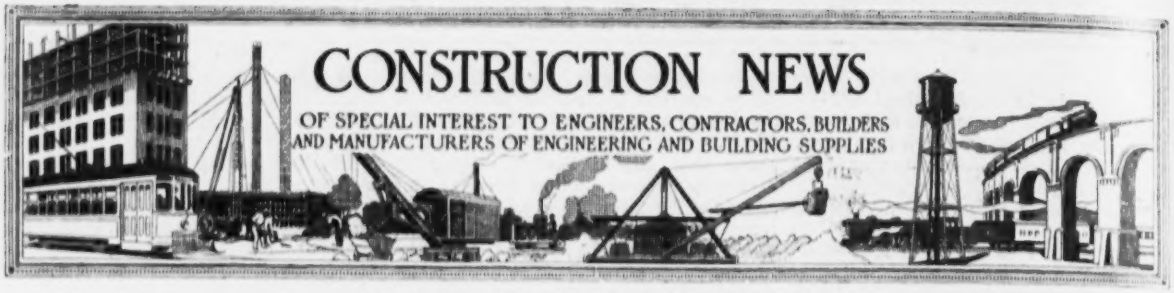
The records of the Bridge Builders' and Structural Society, as collected by its secretary, show that during January, 1919, 12% of the entire capacity of the bridge and structural shops of the country was contracted for.

OBITUARY

HOWARD P. EELLS, of Cleveland, Ohio, who until his death recently was the chairman of the Board of Direction of the Bucyrus Co., held a place of much prominence in the engineering manufacturing field.

Born in 1855, he was graduated from Harvard University in 1878, and began his business career in a Cleveland bank. In 1880 he entered the business of the Bucyrus Co., then located at Bucyrus, Ohio. In moving to South Milwaukee, Wis., to enlarge its works the company suffered from financial difficulties in the panic of 1893. Mr. Eells was appointed one of the receivers of the company, and managed its affairs so successfully that in 1898, when it was discharged from the receivership he was made its active head of the company.

When, in 1911, the company was greatly enlarged and recapitalized, Mr. Eells retired from the presidency and became the chairman of the board of directors. He remained closely interested in its affairs until his recent death.


CONSTRUCTION NEWS
OF SPECIAL INTEREST TO ENGINEERS, CONTRACTORS, BUILDERS
AND MANUFACTURERS OF ENGINEERING AND BUILDING SUPPLIES

Price advances are indicated by **heavy type**; declines by *italics*.

PIG IRON—

	Current	One Month Ago
CINCINNATI		
No. 2 Southern	$35.85	$37.60
Northern Basic	31.80	34.80
Southern Ohio No. 2	32.80	35.80
NEW YORK, Tidewater delivery		
Penna. 2X	36.15	39.55
Southern No. 2 (Silicon 2.25 to 2.75)	39.95	
BIRMINGHAM		
No. 2 Foundry	31.00	34.00
PHILADELPHIA		
Eastern Pa. 2X	36.15*	39.15*
Virginia No. 2	38.10†	40.50†
Basic	33.90*	36.90*
Grey Forge	33.90*	36.90*
Bessemer		39.10*
CHICAGO		
No. 2 Foundry Local	31.00	34.50
No. 2 Foundry Southern	37.20	39.00
PITTSBURGH, including freight charge from the Valley		
No. 2 Foundry Valley	31.00	35.40
Basic	30.00	34.40
Bessemer	32.20	36.60

*F.o.b. furnace. †Delivered

RAILWAY SUPPLIES

STEEL RAILS—The following quotations are per ton f.o.b. Pittsburgh and Chicago for carload or larger lots. For less than carload lots 5c. per 100 lb. is barged extra:

	Pittsburgh		Chicago	
	Current	One Year Ago	Current	One Year Ago
Standard bessemer rails	$55.00	$55.00	$65.00	$60-65
Standard openhearth rails	57.00	57.00	67.00	63-65
Light rails, 8 to 10 lb.	3.13½*	3.13½*	3.13½*	3.13½*
Light rails, 12 to 14 lb.	3.09½*	3.09½*	3.09½*	3.09½*
Light rails, 25 to 45 lb.	3.00*	3.00*	3.00*	3.00*

*Per 100 lb.

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh for carload lots together with the warehouse prices at the places named:

	Pittsburgh				San Francisco
	Current	One Year Ago	Chicago	St. Louis	
Standard spikes, ⅜-in. and larger	$3.70	$3.90	$4.50	$5.04	$6.15
Track bolts	4.90	4.90	5.50	Premium	7.50
Standard section angle bars		3.25	4.45	Premium	5.15

RAILWAY TIES—For fair-sized orders, the following prices per tie hold:

		7 In. x 9 In. by 8 Ft.	6 In. x 8 In. by 8 Ft.
Chicago	Plain	$1.48	$1.33
San Francisco	Douglas Fir—Green	1.35	.96
San Francisco	Douglas Fir—Creosoted	2.70	1.62

Prices per tie at Missouri mills; St. Louis prices about 25c. higher:

Untreated A Grade White Oak 6x8x8		Untreated A Grade Red Oak 6x8x8	
No. 1	$0.70	No. 1	$0.55
No. 2	.80	No. 2	.65
No. 3	.90	No. 3	.75
No. 4	.98		
7x9x8 white oak			1.05
7x9x8 red oak (No. 4) $0.80		No. 5	.87

Note:—Add 36c. each for treatment.

PIPE

STEEL—From warehouses at the places named the following discounts hold for steel pipe:

	Black		
	New York	Chicago	St. Louis
⅜ to 3 in. butt welded	47%	44.9%	47%
2½ to 6 in. lap welded	48%	40.9%	38%
	Galvanized		
	New York	Chicago	St. Louis
⅜ to 3 in. butt welded	27%	29.9%	27%
2½ to 6 in. lap welded	43%	26.9%	43%

Malleable fittings, Class B and C, from New York stock sell at +15% list price. Cast iron, standard sizes, 10% off.

CAST-IRON PIPE—The following are prices per net ton for carload lots:

	New York						
	One Month Current	One Year Ago	One Year Ago	Chicago	St. Louis	San Francisco	Dallas
4 in.	$65.70	$65.70	$58.35	$64.80	$58.00	$82.55	$70.00
6 in. and over	62.70	62.70	55.35	61.80	55.00	79.55	67.00

Gas pipe and 16-ft. lengths are $1 per ton extra.

CLAY DRAIN TILE—The following prices are per 1000 lin. ft.:

	New York				
Size, In.	Current	One Year Ago	St. Louis	Chicago	San Francisco
3	$35.00	$35.00	$22.50	$30.00	
4	51.00	51.00	27.00	40.00	$45.00
5	65.00	65.00	45.00	50.00	65.00
6	90.00	90.00	55.00	60.00	90.00
8	130.00	130.00	100.00	80.80	150.00

SEWER PIPE—The following prices are in cents per foot for carload lots:

	New York					
Size, In.	Current	One Year Ago	St. Louis	Chicago	San Francisco	Dallas
3	$0.117	$0.096		$0.125	$0.09	$0.130
4	.117	.096		.125	.15	.132
5	.1755	.144		.175	.1875	.207
6	.1755	.144	$0.16	.175	.225	.207
8	.273	.224	.22	.25	.3475	.2875
10	.4095	.336	.30	.375	.45	.4025
12	.5265	.432	.43	.475	.60	.5175
15	.702	.576	.65	.63	.9375	.7475
18	.975	.80	.96	1.00	1.275	.9775
20	1.17	.96	1.14	1.20	1.71	1.15
22	1.56	1.28	1.46	1.60		1.495
24	1.755	1.44	1.64	1.80	2.125	1.725
27	2.21	2.145	2.00	2.25		2.5875
30	3.024	2.376	2.70	3.45		3.1625
33	3.96	3.15	3.25	4.00		4.025
36	4.51	3.5875	3.55	4.35		4.60

	3	5	8	12	24	36
Boston	$0.12	$0.18	$0.28	$0.54	$1.80	$5.535
St. Paul	12	18	25	45	1.00	4.75
Denver	09½*					
Seattle	15		33½	.64	2.00	
Kansas City	12	18	25	50	1.80	4.60
Los Angeles	08½	13½	24½	44	1.50	
New Orleans	10½	15½	27	.459	1.75½	
Cincinnati	108	162	252	486	1.62	3.9975
Atlanta	135	2025	315	6075	2.025	4.6125

*4 in.

ROAD AND PAVING MATERIALS

ROAD OILS—Following are prices per gallon in tank cars 8000 gal. minimum f.o.b. place named:

	Current	One Month Ago
New York, 45-65% asphalt	$0.06½	$0.07½
New York, liquid asphalt	.07½	08
New York, binder	.07½	.08
New York, flux	.06½	.07½
St. Louis, 35% asphalt	.09	.09
Chicago, 15-20% asphalt	.10	.10
Chicago, 100% dust layer	.11	.11
Dallas, 40-50% asphalt	.09	.09
Dallas, 60-70% asphalt	.10	.10
Dallas, 75-90% asphalt	.11	.11
San Francisco, 75-95% asphalt, per bbl.	2.10	2.10

ASPHALTUM—Price per ton in packages and bulk in carload lots:

	Brand	Package	Bulk
New York	Texaco	$25.00	$22.00
Chicago	Mexican	35.50	33.50
San Francisco	California	17.00	13.75
Dallas	Texaco and Mexican	32.00	30.00
Seattle	D grade	23.10	
Denver	Trinidad	45.00	
Denver	California	38.00	
St. Louis	Stanolind	20.90	22.90

PAVING STONE—

New York	Manhattan	$2.80 sq.yd.
	Other boroughs	2.80 sq.yd.
New York	5-in. granite	2.80 sq.yd.
Chicago	About 4x8x4 dressed	2.70 sq.yd.
	About 4x8x4 common	2.35 sq.yd.
San Francisco	Basalt block 4x7x8	57.25 per M
Kansas City	Limestone	2.90 sq.yd.
Boston	5-in. granite	98.00 per M
St. Paul	Sandstone	1.25 sq.yd.
Atlanta	Sta. No. (Lithonia, Ga., rock)	1.25 sq.yd.

FLAGGING—

New York	Bronx	$0.20 sq.ft.
	Manhattan	.21 sq.ft.
	Queens, 5 ft. square	.20 sq.ft.
	5x20-in. cross-walk	.70 lin.ft.
Chicago	18 in. wide	.80 lin.ft.

WOOD BLOCK PAVING—

	Size of Block	Treatment	Per Sq.Yd.
New York	3½	16	$3.25
New York	4	16	3.50
Chicago	4	16	3.10
Chicago	3½	16	2.95
Chicago	City specifications		3.10
St. Louis	3½	16	2.45
St. Louis	4	16	2.60
St. Louis, Minneapolis spec.	3½		2.40
St. Louis, Minneapolis spec.	4		2.55
Seattle	4	16	2.55
Boston	3½	16	3.25
Boston	4	20	3.50
Kansas City	4	16	3.00
St. Paul	3½	16	2.50
Dallas	3½	18	3.17
Dallas	4	18	3.56